ARKANSAS AGRICULTURE DEPARTMENT

Specialty Crop Block Grant Program

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Final Report

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Project 1: Arkansas Locally Grown App for Smart Media

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

With the current trend of consumers wanting to buy more local specialty crop products, business at farmers markets and u-pick operations continues to grow. Unfortunately there is a there is not an easy to use mobile resource of this information. This proposal is to create such an app that will provide consumers with an easy way to locate local food:

- farmer's markets
- road side stands
- u-pick operations
- Christmas trees
- Specialty crop based agritourism

In addition to just locating the food this app will also provide a calendar to let consumers know when local specialty crops will be available, as well as help educate consumers about the products they are buying.

Objectives :

1. Develop a single system for collecting information
    a. Combine databases from Arkansas Farm Bureau, Arkansas Agriculture Department, and the UA Division of Agriculture.
2. Create a Mobile App for Apple and Droid devices
    a. Map and search tools for local products
    b. Calendar entry for fruit and produce availability
    c. Food Facts: detailing different production methods and explanation of terminology
    d. News/Push Notifications
3. Promote App in print and social media outlet

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

  Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

  Detail the significant contributions and role of project partners in the project.

  The project developed an application that is available on the App Store and Google Play Store. Velocity Broadband of Mena, Arkansas created the application and has completed updates to the program to comply with recent changes in the ios and google software.

Arkansas Farm Bureau hired an intern during the summer of 2015 to enter all of the data available in the current Arkansas Grown database and the Best Pick database that related to farmers markets, u-pick, and other fruit vegetable, and other consumer focused operations. Additionally, producers continue to register themselves within the system thanks to the University of Arkansas Cooperative Extension and other cooperators efforts promote the app to Market Maker users and other affiliates at numerous producer meetings.

While the main goal of the project, which was to create the app, has been accomplished there are a number of difficulties associated with this project:

- Development of a more complete list of producers in the database. While the database currently includes a wide variety of producers and locations, there are gaps in the data and still a lot of operations that are not included. This lack of a complete list of products and operations could limit the effectiveness of the application with consumers.

- Helping producers realize the importance of a complete profile to help market their operation to potential customers. More complete information including social media pages for their operations would be helpful in marketing their operation to consumers in the application.

This is not a project with a defined end date. Continued updates of the iOS and google software require regular updates to the application. Additionally, constant changes in operations and producers require the database be managed to ensure its longevity.

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.
- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

The main goal of this program was to increase sales among specialty crop producers, such as those with U-pick and direct to consumer sales. This was accomplished through the following objectives:

1. Development of a single system for collecting information - relative information from the three main sources of data (Market Maker, Arkansas Grown, and Best Pick) have been added to the database. Additionally, other producers have signed up through the promotion of the application at various producer meetings across the state.
2. Creation a Mobile App for Apple and Droid devices - the app has been developed and is available in both the App Store and Google Play store.
3. Promote App in print and social media outlets - the app continues to be promoted through cards at producer meetings and through various social media outlets to producers in Arkansas.

To date the application has close to 300 producers signed up in the database and almost 100 downloads of the app from the Apple app Store and the Google Play Store Combined. Over the last year advertisements on social media have helped double downloads from the previous year.

Note: There was a significant increase in the number of users after the advertising this last year (2016) on social media. However, data for the performance measure (increasing sales by 10%) has not been obtained. Subrecipient reported that they had attempted to survey producers to gain sales amounts, but were unable to get sufficient information. AAD requested clarification regarding what steps were taken to obtain the information and what specific issues had prevented the information from being collected, but no response was provided.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

As described above, the application has close to 300 producers signed up in the database and almost 100 downloads of the app from the Apple app Store and the Google Play Store Combined. Over the last year advertisements on social media have helped double downloads from the previous year.

Specialty crop producers including U-Pick Operations, Farm Stands and farmer's markets have all signed up for the App and are seeing benefits from their participation. Consumers are also reaping benefits from the app, as evident from the reviews "Wow! Unbelievably helpful for finding great, fresh produce all around Arkansas."

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

While there is a need for common database that consumers can easily search to find the products they desire, the coordination of all the individuals in these areas can be difficult. There are a number of different producer groups that one must work with before you can begin to develop a comprehensive list. The next challenge is keeping the list current once operations are signed up. With new operations coming online and others changing business plans, you have to ensure the information remains current and relevant.

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Project 2: The Arkansas Gleaning Project

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

According to a USDA survey Arkansas has 19.7% of its citizens dealing with food insecurity. Over 500,000 people in Arkansas are hungry or wonder where their next meal will come from. The state is combating the lack of availability of nutritious foods for low income families as well as a high rate of hunger. Due to this the Arkansas Hunger Relief Alliance set a goal in 2008 of acquiring and dispersing more fresh fruits and vegetables through their member food bank organizations. Fresh fruits and vegetables are difficult to store and transport within the hunger relief system. When they are available they must be transported immediately to local pantries and shelters and then made available quickly to clients. When fruits and vegetables are available they are in high demand by clients as they are very popular items. The transporting of fruits and vegetables from out of state sources is expensive and risky. Since they are perishable items they must be transported in refrigerated trucks and acquired loads often arrive bruised and rotting. The food banks in Arkansas are always in need of fresh fruits and vegetables to provide to the local pantry and agency system in the state. Due to the high need and complexity of delivery and storage the Alliance began looking for new and innovative ways to provide access to fresh fruits and vegetables and formed the Arkansas Gleaning Project. Gleaning is simply the act of following behind farmers after their harvests and picking any leftovers from the fields and utilizing excess, unmarketable produce. The concept is perfect for Arkansas due to the large agricultural base to access foods and the high rate of volunteerism throughout the state. The project began in 2008 and has saved over 8.5 million pounds of fresh, nutritious food for Arkansans in need. Produce is picked and field packed by volunteers or Arkansas Department of Correction Regional Maintenance Crews. It is transported from the field directly to the nearest food bank.

Feeding America reports Arkansas as having the one of highest incidence of child hunger in the United States with more than 28%. The National Foundation to End Senior Hunger maintains that Arkansas leads the nation in senior hunger with 25.44%. Even when food is available, many people do not have access to nutritious options like fruits and vegetables or the skill and knowledge to prepare the foods. In a study conducted by FRAC in 2011 titled *A Half Empty Plate: Fruit and Vegetable Affordability and Access Challenges in America*, it is reported that those with annual household incomes less than $24,000 experienced significant problems accessing affordable fruits, vegetables, and healthy foods. Processed and sugary foods are often far more accessible and affordable to low-income households. According to FRAC and Feeding America, those who do not have access to affordable healthy food options also often experience more stress, obesity, diabetes, high blood pressure, asthma, growth delays, and cognitive development impediments (Cook & Jeng, 2009).

The Specialty Crop Block Grant and the Arkansas Agriculture Department have helped the Arkansas Gleaning Project build and expand since 2012. This investment, along with a lot of hard work, is producing results. The Arkansas Gleaning Project has consistently accessed over one million pounds of produce each year during this period. For the first time, we have exceeded the two million pound goal during the 2016 gleaning season. Over 2.1 million pounds of fresh produce have been made available to Arkansans in need. We have also increased our grower base to 49. Since inception in 2008, over 8.5 million pounds of produce have been rescued from the field and/or diverted from the landfill. In addition to the obvious benefit to clients receiving this food, there are benefits to the growers and retailers. Growers receive a tax deduction for their donation, however they seem to receive more value from

increasing their yields with the harvest of the excess and unmarketable products and the satisfaction gained from helping others. In October 2015, clients at three large food pantries in central Arkansas were surveyed to measure the success of the Arkansas Gleaning Project. Of the eighty-seven families surveyed, 85% reported that the program increased the amount of fresh fruits and vegetables their family consumed and 61% said they purchased additional produce because of their exposure to it through the program. These are significant percentages that show the program makes a difference in the diets of Arkansans in need.

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

The Arkansas Gleaning Project is a full-time program of the Arkansas Hunger Relief Alliance. Although gleaning activities are limited to harvest seasons, network and relationship building occur year round. During the winter of 2014 and 2015, the Director of Food Sourcing and the gleaning coordinator for the Alliance called on farmers, producers and packers during the winter months to gain their involvement in the gleaning program. The same staff worked with the Society of St. Andrew to develop and increase volunteer networks across the state for gleaning activities. Staff and logistical support were provided at each gleaning along with the Arkansas Department of Correction, when appropriate. The Arkansas Gleaning Project is and has been prominently displayed on the Alliance website and is a presentation subject of every Alliance employee throughout the year.

The Arkansas Gleaning Project made great strides during 2014 and 2015 with new partnerships and expansions of existing ones. Fifteen new farmers have joined the program increasing our variety and producing almost 1.5 million pounds of gleaned produce in 2014 and over one million pounds in 2015, in spite of these difficult years for farmers. These new partnerships raised our grower participation number to 42, far exceeding the goal of 30. Our partner, Society of St. Andrew has been successful in adding staff positions in Arkansas. The two part-time positions helped increase our reach for the number of gleanings held and volunteers recruited. 2016 has been a record breaking season which saw 2.1 million pounds and the grower participation number rising to 49.

Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

Only specialty crops are dealt with in the Arkansas Gleaning Project.

Detail the significant contributions and role of project partners in the project.

The Arkansas Hunger Relief Alliance maintains staff that work to increase grower participation, volunteer participation and logistical support for all gleanings. The Society of St. Andrew maintains staff to do the same. These collaborative efforts along with the Arkansas Department of Correction have helped to build a gleaning project that has become a national model among Feeding America food banks.

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.

- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

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The goal of this project was to increase the consumption and interest in fruits and vegetables by Arkansans in need. While every bit of produce gleaned is important, the poor weather conditions limited the amount of produce available. As farmers suffer, so does the gleaning project. Even the addition of several new growers to the program did not get our numbers to goal. In fact, 2015 was almost a half million pounds below 2014 gleaned pounds. The desired output in this proposal was to glean two million pounds in a season. We were finally able to accomplish this in 2016 by obtaining 2.1 million pounds of produce.
Clients were surveyed during October 2015 to measure the performance of the program. Of the eighty-seven families we were able to reach, 85% reported that the program increased the amount of fruits and vegetables their family consumed and 61% said they purchased additional produce because of their exposure to it through the program. This is below the target of 95% and 90% respectively, but is still an impressive figure that shows the program makes a difference in the diets of Arkansans in need. Our benchmark study in 2012 indicated that 88% of clients purchased more and 95% ate more specialty crop items due to the program. Interesting enough, 2012 was the first year the program broke the million pound mark, making produce seem in great supply. The Arkansas Gleaning Project has consistently exceeded that mark since that time, making produce seem scarce in year like 2015 with only a million pounds.

Goal 1 is to contribute to overall health and wellness of low-income Arkansans.

This will be done by the following objective:

- Increasing accessibility and distribution of fruit and vegetables by acquiring two million pounds of produce through gleaning, concurrent picking, and Grow-a-Row.

Goal 2 is to create programmatic sustainability by establishing and utilizing collaborative partnerships.
This will be done by the following objectives:

- Increasing the number of Arkansas farmers participating in the Gleaning Project to 25
- Increasing participation rates of the Arkansas Department of Correction by 50%

The Arkansas Gleaning Project is contributing to health and wellness of low-income Arkansans by increasing the amounts of fresh fruits and vegetables available in their diets. During this grant period, 2014 – 2016, almost 5 million pounds of produce were made available to Arkansans in need. This was done by increasing the number of farmers participating in the program to 49, far past the goal of 30. The Arkansas Department of Correction currently picks 80% of all gleaned product.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The Arkansas Hunger Relief Alliance is the state association for organizations and individuals interested in hunger relief. Food obtained through the Arkansas Gleaning Project is distributed to our member food banks. These are Arkansas Foodbank, Little Rock; Harvest Regional Food Bank, Texarkana, AR; River Valley Regional Food Bank, Ft. Smith; Northwest Arkansas Food Bank, Bethel Heights; Food Bank of North Central Arkansas, Norfork; Food Bank of Northeast Arkansas, Jonesboro. These six Feeding America food banks serve over 800 feeding agencies in all seventy-five counties of Arkansas. During this grant cycle, 2014 – 2016, the Arkansas Gleaning Project provided 4,866,928 pounds of fresh produce to these food banks. This is the equivalent of 4,055,773 meals.
The growers also benefitted. Not only did they have the satisfaction of helping their neighbors in need, they also receive a tax deduction for the donation. Also, consistent gleaning raises harvest amounts. In time, this can have a positive increase on the grower's average yield.

Almost one in five Arkansans (19.7%) aren't sure where they will get their next meal. This represents over 584,000 Arkansans, including 202,000 children are living with food insecurity. According to Hunger in America 2014, the Alliance network serves over 709,000 unduplicated individuals per year in Arkansas.

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

As non-farmers, The Arkansas Gleaning Project participants has learned many lessons. The weather plays an important part of the success of the program. We are learning what it is to be a farmer and it is not an easy job. If growers have a bad year, the gleaning project has a bad year. If the gleaning project is having a great year, growers are suffering. Only when weather conditions are near normal with just enough rain, but not too much, is the grower and gleaning project mutually successful. 2016 has been one of those years. Although the Arkansas Gleaning Project did meet the goals of the project it was unexpected to take so long. We intended to meet the goals and end the project in 2014. Because of the weather issues, gleaning numbers were not on track for the 2014 gleaning season. We did not adjust the goals of the program but kept on working. During 2015, we were able to add enough growers to meet that part of the goal but still were not able to glean enough pounds. In 2016, conditions were better, growers and partners were in place and we met the 2 million pound goal.

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Project 3: Arkansas Fresh-Market Blackberries: Identifying Marketable Attributes for Blackberry Producers

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

Locally-grown fresh-market blackberries (*Rubus subgenus Rubus*.) have potential for an increased role in U.S. fresh markets. There is a critical need to determine the role that fresh-market blackberry genotypes (advanced selections and cultivars) will play in potential expansion of U.S. markets. The University of Arkansas fruit breeding program is one of the world's largest blackberry breeding programs and has released the majority of the cultivars used in U.S. fresh-market production. This project of the University of Arkansas offers a collaborative approach to address challenges that face small-fruit producers by *identifying compositional, nutraceutical, and sensory attributes of fresh-market blackberries that drive marketability* through the following objectives:

1. Identify composition-based marketable attributes of fresh-market blackberries
Determine composition and nutraceutical attributes of fresh-market blackberry genotypes

2. Determine consumer-driven marketable characteristics of fresh-market blackberries
Conduct descriptive and consumer analysis to determine key sensory characteristics of fresh-market blackberry genotypes

3. Disseminate information to fresh-market blackberry producers and consumers
Provide producers with information on the consumer attributes that drive marketability for fresh-market blackberry genotypes to develop marketing and pricing strategies.

By providing data and materials to be used in marketing and promotion, we can create a unique opportunity to boost consumer demand for fresh-market blackberries. This increased demand, along with expanding cultivar options and enhanced fruit quality will benefit growers. The timing for this project was right, due to both increased interest by consumers and marketers for locally produced foods, and the increased consumer interest in fruit consumption for nutraceutical benefits that has and will positively impact demand for and purchase of fresh-market fruit.

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

The blackberries were grown and harvested at the University of Arkansas Fruit Research Station, Clarksville in June 2014. Five University of Arkansas released cultivars (Natchez, Osage, Ouachita, Prime Ark® 45, and Prime Ark® Traveler) and 24 advanced selections were

harvested. After harvest, the fruit was taken to the Department of Food Science, University of Arkansas, Fayetteville for evaluation of physiochemical and nutraceutical attributes. Five cultivars and six selections were evaluated by a descriptive and consumer sensory panels. This research showed the following results for fresh-market blackberries:

- Insight into physiochemical attributes and variation by genotype
- How attributes are perceived by consumers
- Verified nutraceutical levels
- Identification of marketable attributes by descriptive and consumer sensory panels
- Established a descriptive sensory lexicon
- Appearance attributes (size, shape, color and glossiness) can influence consumer liking
- Consumers liked mid-sized berries rather than large berries
- Sweetness was a positive attribute, but sourness had more of a negative impact on liking
- Balance of sweetness and sourness should be considered
- The positive drivers were glossiness, loose particles, overall aromatic impact, blackberry aromatic and uniformity of drupelets associated with the A-2491
- Established commercial composition standards
    - Commercially-marketed fresh-market blackberries should have a berry weight of 8-10 g, soluble solids of 9-11%, titratable acidity of 0.9-1% and a soluble solids/titratable acid ratio of 10-13.
- The total output of disseminated information for this blackberry project to date is 2 referred journal publications, 5 published abstracts, 3 poster presentations, 5 oral presentations and 1 invited presentation.
- Identified marketable attributes that should be considered when advancing selections for commercial release

Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

This project only studied blackberries. No funds were used for non-specialty crops.

Detail the significant contributions and role of project partners in the project.

This project was done as a collaborative effort between the Institute of Food Science and Engineering, Food Science Department and Horticulture Department at the University of Arkansas System Division of Agriculture. Dr. Renee Threlfall, PI for the project, designed and implemented this study working with Dr. John Clark and Dr. Luke Howard. Drs. Clark and Threlfall supervised the Horticulture Department honors student, Olivia Hines, who was working on her Honors Project as part of this grant. Miss Hines worked at the Fruit Research Station, Clarksville, AR (where the fruit was produced) and in laboratories at the Department of Food Science. Cindi Brownmiller, Dr. Howard's technician, completed the nutraceutical analysis of the samples. Dr. Threlfall worked with Miss Hines on the data collection and analysis. Dr. Threlfall finalized the statistical analysis of the data and organizing the data for presentations, posters and publications.

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.
- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.

- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

The challenge of this research was to plan a complete study for a fresh-market crop with variable harvest times and unpredictable weather for harvest, particularly when arranging with sensory evaluations. Eleven blackberry genotypes, five cultivars and six selections, from the University of Arkansas Fruit Breeding Program were evaluated for both physiochemical and sensory attributes. This is one of the first research publications on fresh blackberry genotypes to comprehensively compare physiochemical attributes (berry and pyrene attributes, composition and nutraceutical content) of blackberries with sensory attributes (descriptive and consumer sensory).

Physiochemical analysis

Evaluations for physiochemical attributes of the blackberries were done at the Department of Food Science, University of Arkansas, Fayetteville. Three samples of approximately 100 g of berries for each genotype were stored at -20 °C until analyzed. A total of 29 genotypes were evaluated (Table 1) for physiochemical attributes to provide data for the University of Arkansas Fruit Breeding Program, but only 11 genotypes (Table 2) were used for the sensory analysis.

Berry and pyrene attributes. The berry and pyrene attributes of the blackberries varied significantly by genotype, particularly size attributes (Table 2). The blackberries had berry weights from 6.0 to 14.3 g, berry lengths from 27.5 to 43.7 mm, berry widths from 22.2 to 26.9 mm, drupelets/berry from 50.2 to 125.8, pyrene weight/berry from 0.18 to 0.43 g and pyrenes/berry from 51.0 to 115.0. 'Natchez' had the greatest berry weight, berry length, drupelets/berry, pyrene weight/berry and pyrenes/berry. A-2453 had the smallest berry weight, berry length, drupelets/berry, pyrene weight/berry and pyrenes/berry. Although A-2453 had lower yields than other University of Arkansas cultivars limiting its commercial potential, it is valuable as a parent due to unique firmness and post-harvest potential (J.R. Clark, personal comm.).
Composition. Composition values were within a commercially acceptable range for fresh blackberries. The blackberries had soluble solids levels 8.1 to 11.0%, pH values from 3.0 to 3.6, titratable acidity from 0.7 to 1.4% and soluble solids/titratable acidity ratio of 6.2 to 16.5. The influence of soluble solids and titratable acidity on perceived flavor is complex in a blackberry matrix. A-2491 had the highest soluble solids and A-2418 had the lowest, while A-2418 had the highest titratable acidity and 'Ouachita' had the lowest. Soluble solids/titratable acidity ratio is often used to determine the balance of perceived sweetness or sourness in a product. 'Ouachita' had the highest soluble solids/acid ratio (16.5), A-2418 had the lowest (6.2), but A-2491 (highest soluble solids) had a soluble solids/titratable acidity ratio of 13.5.
Nutraceutical content. The blackberries had total ellagitannins content from 20.6 to 45.4 mg ellagic acid eqv/100 g, total flavonols from 7.7 to 16.1 mg rutin eqv/100 g, total anthocyanins from 55.4 to 247 mg acy/100 g and total phenolics from 434 to 606 mg gallic acid eqv/100 g. The phenolic contents varied greatly among genotypes. 'Osage' had the highest total flavonols and total anthocyanins. 'Prime-Ark® Traveler' had the lowest total flavonols and total anthocyanins, and 'Ouachita' had the lowest total ellagitannins and total phenolics. A-2434 had the highest total ellagitannins. A-2453 had the highest total phenolics, but was the smallest berry with a relatively high soluble solids level and low titratable acidy.

Table 1. Physiochemical attributes for blackberry genotypes Clarksville, AR 2014.

Genotype	Soluble solids (%)	Berry weight (g)	Drupelet number/ berry	Pyrenes/ berry
A-2252	9.80 cdef [z]	6.00 ghijk [y]	61.33 ghi	58.44 ijk
A-2312	8.83 ef	8.61 cdefghi	89.00 bcdefg	90.33 cdefg
A-2316	9.90 cdef	7.13 efghijk	89.67 bcdefg	91.89 bcdefg
A-2416	9.47 def	11.06 bcd	88.55 bcdefg	83.22 defghij
A-2418	8.07 f	9.66 bcde	84.22 cdefgh	94.22 bcdefg
A-2419	10.03 cdef	6.68 efghijk	97.89 abcde	106.89 abcde
A-2428	9.87 cdef	8.51 cdefghi	68.44 fghi	69.11 fghijk
A-2434	9.73 def	9.03 cdefg	86.22 cdefgh	88.78 cdefgh
A-2435	10.33 bcdef	9.19 cdef	101.89 abcd	96.11 abcdef
A-2444	12.30 abc	9.32 cde	52.89 i	54.00 k
A-2450	8.93 ef	9.05 cdef	92.22 bcdef	92.00 bcdefg
A-2452	10.47 bcdef	12.66 ab	110.44 abc	111.78 abcd
A-2453	10.63 bcde	6.01 ghijk	50.22 i	51.00 k
A-2454	10.20 bcdef	8.07 defghij	64.33 fghi	68.56 fghijk
A-2473	10.90 abcde	5.78 hijk	73.11 efghi	76.00 fghijk
A-2480	12.67 ab	5.23 jk	67.44 fghi	70.89 fghijk
A-2487	11.83 abcd	4.90 k	59.11 hi	59.89 hijk
A-2491	10.97abcde	9.70 bcde	81.78 defgh	84.78 defghij
APF-238	13.33 a	5.64 ijk	53.34 i	55.89 jk
APF-266	9.13 ef	11.12 bc	110.33 abc	123.33 a
APF-268	9.93 cdef	9.07 cdef	78.22 defghi	78.22 efghijk
APF-290	10.17 bcdef	6.85 efghijk	82.56 cdefgh	88.22 cdefgh
APF-293	8.67 ef	8.97 cdefg	115.67 ab	120.66 ab
APF-298	11.20 abcde	6.27 fghijk	82.89 cdefgh	86.44 cdefghi
Natchez	10.17 bcdef	14.26 a	125.83 a	115.00 abc
Osage	8.90 ef	7.29 efghijk	70.22 efghi	72.33 fghijk
Ouachita	10.60 bcdef	8.80 cdefgh	69.78 efghi	66.78 ghijk
Prime-Ark® 45	9.47 def	7.64 efghijk	85.78 cdefgh	90.22 cdefg
Prime-Ark® Traveler	8.97 ef	8.45 cdefghi	76.11 defghi	78.44 efghijk

[z] Genotypes were evaluated in triplicate (n=3). Means with different letter(s) for each attribute are significantly different ($p < 0.05$) using Tukey's HSD

Table 2. Berry, pyrene, and composition attributes for blackberry genotypes, Clarksville, AR 2014.

Genotype	Berry weight (g)	Drupelets/ berry	Pyrenes/ berry	Soluble solids (%)	pH	Titratable acidity (%)[z]	Soluble solids/ titratable acidity ratio
A-2416	11.06 ab [y]	88.55 b	83.22 b	9.47 ab	3.16 ab	1.01 ab	9.54 ab
A-2418	9.66 bc	84.22 b	94.22 ab	8.07 b	3.08 b	1.35 a	6.17 b
A-2434	9.03 bcd	86.22 b	88.78 ab	9.73 ab	3.05 b	1.16 ab	9.14 ab
A-2450	9.05 bcd	92.22 b	92.00 ab	8.93 ab	3.00 b	1.16 ab	7.68 ab
A-2453	6.01 d	50.22 c	51.00 c	10.63 a	3.37 ab	0.75 ab	14.63 ab
A-2491	9.70 bc	81.78 b	84.78 b	10.97 a	3.20 ab	0.97 ab	13.49 ab
Natchez	14.26 a	125.83 a	115.00 a	10.17 ab	3.17 ab	1.03 ab	9.93 ab
Osage	7.29 cd	70.22 bc	72.33 bc	8.90 ab	3.58 a	0.69 b	12.82 ab
Ouachita	8.80 bcd	69.78 bc	66.78 bc	10.60 a	3.43 ab	0.66 b	16.46 a
Prime-Ark® 45	7.64 cd	85.78 b	90.22 ab	9.47 ab	3.38 ab	0.81 ab	12.30 ab
Prime-Ark® Traveler	8.45 bcd	76.11 b	78.44 bc	8.97 ab	3.20 ab	0.92 ab	10.23 ab
P value	<0.0001	<0.0001	<0.0001	0.0065	0.0020	0.0135	0.0365

[z] Calculated as percent citric acid.
[y] Genotypes were evaluated in triplicate. Means with different letter(s) for each attribute are significantly different ($p < 0.05$) using Tukey's Honestly Significant Difference.

Descriptive and Consumer Sensory

Descriptive and consumer sensory analyses of the fresh blackberries were performed at the Sensory and Consumer Research Center at the University of Arkansas, Fayetteville. Five cultivars (Natchez, Osage, Ouachita, Prime Ark® 45, and Prime Ark® Traveler) and 6 advanced selections evaluated.

Descriptive Sensory Analysis

The descriptive panelists (n=9) developed a lexicon of sensory terms for blackberries through consensus. The panelists were trained to use to a modified Sensory Spectrum® method, an objective method for describing the intensity of attributes in products using references for the attributes. The descriptive panel identified fresh blackberry attributes for appearance (n=8), basic tastes (n=3), feeling factors (n=2), aromatics (n=8), texture (n=7) and uniformity of sample (n=2) and evaluated those attributes using a 15-point scale. Major attributes of interest are reported in Table 3.

Descriptive sensory analysis. The lexicon developed by the descriptive panel included references used by the panelists to evaluate the appearance, basic tastes, feeling factors, aromatics and texture of fresh blackberries. This lexicon can be used by other programs to evaluate the attributes of fresh blackberries or modified for use with other fresh fruit.

Appearance attributes. The appearance attributes of blackberries are an important attribute for fresh market because consumers can purchase blackberries based on appearance in a clamshell container. The appearance attributes of the blackberries evaluated included color, uniformity of color, size of berry, size of drupelets, uniformity of drupelets, amount of styles, amount of blemishes and glossiness. The color of the blackberries was scored in the black range. The uniformity of color was 87 to 94% indicating mostly

black berry and drupelet color. Some red drupelets were present on some genotypes of the berries stored overnight at 2 °C prior to evaluation. 'Natchez' was the largest berry and A-2453 the smallest. A-2491 had larger and more uniform drupelets. 'Prime-Ark® 45' had the smallest drupelets and 'Ouachita' had the least uniform drupelets on a berry. A-2453 was perceived to have the least amount of styles on a berry, while 'Ouachita' had the most. The amount of blemishes on the berries were low (0-25%) with A-2453 the least. The descriptive panel identified A-2453 as the glossiest berry.

Basic tastes. The panelists evaluated the basic tastes (sweet, sour and bitter) of the blackberries. Although berry soluble solids levels ranged from 8 to 11%, panelists found no significant differences in descriptive sweetness among the genotypes. A-2491 was rated as the least sour and bitter and A-2416 as the most sour. As compared to A-2491, A-2416 had 1.5% less soluble solids, 0.3% more titratable acidity, and 30% less soluble solids/titratable ratio.

Feeling factors. The panelists evaluated the feeling factors (astringent and metallic) of the blackberries and found no differences among the genotypes.

Aromatic attributes. The aromatic attributes (volatiles perceived by the olfactory system while chewing a sample in the mouth) of the blackberries included overall aromatic impact, blackberry, earthy/dirty, green/unripe, overripe/fermented, chemical, mold/mildew and metallic. 'Natchez' having the highest overall aromatic intensity. There was no difference in the genotypes for blackberry, mold/mildew or metallic aromatics. The overripe/fermented, chemical, earthy/dirty and green/unripe aromatic intensities were very low. The overall and blackberry aromatics were the highest scored intensities.

Texture attributes. The texture attributes included firmness, moisture release, popping/bursting, size of seeds, amount of seeds, toothpack and loose particles). A-2453 was the most firm, and 'Natchez' and 'Prime-Ark® 45' were the least firm. A-2453 had a significantly higher popping/bursting attribute as compared to the other genotypes, which is a unique trait of this genotype. The panelists could not identify differences in the size of the pyrenes, the amount of pyrenes or loose particles of the blackberry genotypes evaluated.

Table 3. Descriptive sensory appearance, basic tastes, aromatic and firmness attributes for blackberry genotypes evaluated on a 15-point scale (0=less of the attribute and 15=more of the attribute in terms of intensity), Clarksville, AR 2014.

Genotype	Size of berry	Glossiness	Sweet	Sour	Overall aromatic impact	Firmness
A-2416	10.36 b	8.35 f	3.61 a [z]	5.40 a	7.85 bcde	3.69 bc
A-2418	10.41 b	10.37 de	4.11 a	4.84 abc	7.96 abcd	3.94 ab
A-2434	10.71 b	9.77 e	3.79 a	4.93 ab	7.64 e	3.80 bc
A-2450	10.42 b	11.44 abc	3.71 a	4.62 bcd	7.74 cde	3.62 cde
A-2453	7.10 e	12.17 a	3.86 a	4.12 cde	7.92 abcde	4.21 a
A-2491	10.72 b	11.62 ab	4.20 a	3.84 e	8.07 ab	3.36 ef
Natchez	12.08 a	11.39 bc	4.35 a	3.87 e	8.16 a	3.18 f
Osage	8.19 d	10.34 de	4.32 a	4.27 bcde	7.66 de	3.56 cde
Ouachita	8.43 cd	10.32 de	4.21 a	4.23 bcde	7.89 abcde	3.63 cd
Prime-Ark® 45	8.64 cd	10.22 de	3.73 a	4.33 bcde	7.94 abcd	3.14 f
Prime-Ark® Traveler	9.35 c	10.86 cd	4.23 a	3.95 de	7.99 abc	3.42 de
P value	<0.0001	<0.0001	0.242	<0.0001	0.022	<0.0001

[z] Genotypes were evaluated in duplicate by 9 trained panelists. Means with different letter(s) for each attribute are significantly different ($p < 0.05$) using LSD.

Consumer Sensory Analysis

Consumers were recruited from a database (n~5,500) based on consumption habits and liking of fresh blackberries. The consumer panel (n=74) evaluated appearance, size, shape, color, overall impression, overall flavor and firmness of fresh blackberries on a 9-point verbal hedonic scale and blackberry flavor, sweetness, tartness, bitterness, astringency, firmness, crispness and seediness of blackberries on a 5-point Just About Right (JAR) scale (Table 4).
Consumers indicated that they purchased fresh blackberries at a grocery store (73%), farmers market (55%), pick-your-own farm (32%), other locations (12%), natural food stores (8%) and food co-ops (5%). Twenty-six percent of the consumers indicated that they consumed fresh blackberries once per week to once per month. The consumers typically purchase fresh blackberries with quality (77%), availability, seasonality and price (66%) and consistency (8%).

Hedonic liking scale. All of the attributes evaluated by consumers for the blackberry genotypes in this study were scored from 5 to 8 (5="neither like nor dislike", 6="like slightly", 7="like moderately, and 8="like very much") on the hedonic scale (Table 4). 'Prime-Ark® Traveler' (8.5 g berry) had the highest liking scores for appearance, while A-2416 (11 g berry) had the lowest for appearance, size and color. Consumers liked a medium-sized berry versus a larger berry. Consumer panelists liked the firmness of the genotypes, but found no differences among genotypes. In terms of overall impression and overall flavor, A-2491 and 'Prime-Ark® Traveler' had the highest liking values, while A-2434 had the lowest. A-2491 and 'Prime-Ark® Traveler' had a 9 g berry weight with 10% soluble solids, 0.95% titratable acidity and a soluble solids/titratable acid ratio of 11.8.
Just About Right scale. For analysis, the JAR data was collapsed to "Too Low", JAR and "Too Much". Seventy-seven percent of the consumers found 'Ouachita' (8.8 g weight, 29 mm length and 27 mm width) JAR in terms of blackberry size, followed by 'Prime-Ark® Traveler' and 'Prime-Ark® 45'. Consumers

found A-2491 JAR for astringency (89%) and sourness (78%). Firmness and crispness had similar results with 89% of the consumers finding A-2418 JAR. 'Natchez' was 90% JAR for seediness. 'Prime-Ark® Traveler' and A-2491 had JAR for sweetness of 61% and 70%, respectfully.

Table 4. Consumer sensory attributes for blackberry genotypes evaluated on a 9-point scale hedonic scale (1=dislike extremely, 5=neither like nor dislike, 9=like extremely), Clarksville, AR 2014.

Genotype	Appearance	Size	Shape	Color	Overall impression	Overall flavor	Firmness
A-2416	6.76 d [z]	6.62 c	6.96 a	7.12 d	5.88 ef	5.76 ef	6.82 a
A-2418	7.27 bc	6.93 bc	7.28 a	7.64 bc	6.16 de	6.07 de	7.20 a
A-2434	7.09 cd	7.01 bc	7.08 a	7.59 bc	5.42 f	5.27 f	6.81 a
A-2450	7.39 abc	7.11 ab	6.95 a	7.61 bc	5.88 ef	5.70 ef	6.88 a
A-2453	7.59 ab	7.16 ab	7.31 a	7.93 a	6.59 bcd	6.51 cd	6.95 a
A-2491	7.46 abc	7.34 ab	7.35 a	7.86 ab	7.28 a	7.26 a	7.31 a
Natchez	7.34 abc	6.95 bc	7.26 a	7.66 abc	7.07 ab	6.92 abc	6.99 a
Osage	7.35 abc	7.01 bc	7.14 a	7.82 abc	6.91 abc	6.73 abc	6.78 a
Ouachita	7.19 c	7.20 ab	7.26 a	7.54 c	6.58 bcd	6.55 bcd	7.26 a
Prime-Ark® 45	7.65 a	7.46 a	7.50 a	7.70 abc	6.51 cd	6.41 cd	6.96 a
Prime-Ark® Traveler	7.68 a	7.49 a	7.46 a	7.88 ab	7.18 a	7.09 ab	7.11 a
P value	<0.0001	0.003	0.054	<0.0001	<0.0001	<0.0001	0.157

[z] Genotypes were evaluated by 74 consumer panelists. Means with different letter(s) for each attribute are significantly different ($p < 0.05$) using Least Significant Difference.

Comparisons between physiochemical and sensory

Principal Component Analysis were used to determine the relationship between the physiochemical and sensory data. Three principal components explaining 62.4% of variance of physicochemical and descriptive data were identified using means as the data matrix (Table 5). Overall liking scores were regressed against the three principal components to determine positive and negative drivers of consumer liking for fresh blackberries. Significant effects were found for principal components 1 and 3. Positive and negative drivers of liking were identified for these blackberry genotypes. The positive drivers in Principal Component 1 were glossiness, loose particles, overall aromatic impact, blackberry aromatic and uniformity of drupelets associated with the A-2491, while the negative drivers were bitterness, sourness, amount of blemishes, amount of seeds, green/unripe and metallic associated with A-2434. Though not significant, the Principal Component 2 had non drivers of firmness and chemical associated with A-2453 and drupelets/berry, pyrenes/berry, berry weight, size of berry and moisture release associated with 'Natchez'. The positive drivers in Principal Component 3 were berry width, sweetness, pH and amount of styles associated with 'Ouachita' and 'Osage', while the negative drivers were associated with A-2450.

Table 5. Drivers of liking for fresh blackberries determined by Principal Component Analysis [z], Clarksville, AR 2014.

Principal Component	Low on Dimension 1	High on Dimension 2
1	**Positive Drivers:** Glossiness, loose particles, overall aromatic impact, blackberry aromatic, uniformity of drupelets *Key Sample:* A-2491	**Negative Drivers:** Bitterness, sourness, amount of blemishes, amount of seeds, green/unripe, metallic *Key Sample:* A-2434
2	**Nondrivers:** Firmness, chemical *Key Sample:* A-2453	**Nondrivers:** Drupelets/berry, pyrenes/berry, berry weight, size of berry, moisture release *Key Sample:* Natchez
3	**Negative Drivers:** Narrow berry, lower intensities of sweetness, pH, amount of styles *Key Samples:* A-2450	**Positive Drivers:** Wider berry, higher intensities of sweetness, pH, amount of styles *Key Samples:* Ouachita and Osage

[z] Three Principal Components explaining 62.4% of variance of analytical and descriptive data were identified using means as the data matrix. Significant effects were found for Principal Components 1 and 3 (P = 0.0003 and 0.0130, respectively).

Objective 1. Identify composition-based marketable attributes of fresh-market blackberries

Determine composition and nutraceutical attributes of fresh-market blackberry genotypes

Step 1 Composition Analysis: The pH, titratable acidity, and soluble solids levels of approximately 29 fresh-market blackberry genotypes were measured.

Status: Complete September 2014

Step 2 Nutraceutical Analysis: The nutraceutical composition of 29 fresh-market blackberry genotypes were measured.

Status: Complete May 2015

Objective 2. Determine consumer-driven marketable characteristics of fresh-market blackberries

Conduct descriptive and consumer analysis to determine key sensory characteristics of fresh-market blackberry genotypes

Step 1 Consumer Sensory Analysis: Consumer sensory analysis of the fresh-market blackberry genotypes were conducted at the Sensory Research and Consumer Center in the Food Science Department at the University of Arkansas.

Status: Complete July 2014

Step 2 Descriptive Sensory Analysis: Descriptive sensory analysis of the fresh-market blackberry genotypes were conducted at the Sensory Research and Consumer Center in the Food Science Department at the University of Arkansas.

Status: Complete July 2014

Step 3 Preference Mapping: External preference mapping were used to unravel drivers of liking for fresh-market blackberries.
Status: Complete December 2014

Objective 3. Disseminate information to fresh-market blackberry producers and consumers

Provide producers with information on the consumer attributes that drive marketability for fresh-market blackberry genotypes

Step 1 Generating Outreach Plan: Information on sensory profiles and composition and nutraceutical attributes were generated to support outreach initiatives of the project.
Status: Complete September 2015

Step 2 Disseminating Outreach Plan: The information will be presented at field meetings, workshops, web-based seminars, and written reports/handouts to introduce the evaluated genotypes.
Status: Complete September 2016

The total output of disseminated information for this blackberry project to date is 2 referred journal publications, 5 published abstracts, 3 poster presentations, 5 oral presentations and 1 invited presentation.

A manuscript of the 2014 blackberry data from this project is "in press" with a tentative publication date of November 2016 in the HortScience journal. There is another publication from this data in progress for the Journal of Sensory Science. Several presentations and posters were given on the results from this project in 2015 and 2016 and more are scheduled for 2017.

Publications

Threlfall, R.T., O.S. Hines, J.R. Clark, L.R. Howard, C.R. Brownmiller, D.M. Segantini and L.J.R. 2016. Evaluation of Physiochemical and Sensory Attributes of Fresh Blackberries Grown in the Southeastern United States. HortScience, In Press

Threlfall, R.T., O.S. Hines, and J.R. Clark. 2015. Commercial Attributes of Fresh Blackberries Identified by Sensory Panels. XI International Rubus and Ribes Symposium. June 21-24, 2015, Asheville, NC. International Society for Horticultural Science, Acta Horticulturae, Symposium Proceedings, 1133:391-396

Abstracts Published

Threlfall*, R.T., D.M. Segantini, and J.R. Clark. 2016. Descriptive Sensory Attributes of Arkansas Blackberries Harvested Multiple Years. American Society for Horticultural Science Annual Conference, August 8-11, Atlanta, GA. Poster #264

Threlfall*, R.T., D.M. Segantini, and J.R. Clark. 2016. Sensory and Composition Attributes of Arkansas Blackberry Cultivars. American Society for Horticultural Science Annual Conference, August 8-11, Atlanta, GA.

Threlfall, R. T., O. Hines, D.M. Segantini, J. Clark. 2015. Aromatic impact of fresh blackberries identified by a descriptive sensory panel. HortScience 50(9) (Supplement) – 2015 American Society for Horticulture Science Annual Conference. P. S239.

Hines, O. S., J. R. Clark, R. T. Threlfall. 2015. Attributes of Fresh-Market Blackberries Identified by a Trained Descriptive Panel. HortScience 49(9) (Supplement) – 2015 Southern Region-American Society for Horticulture Science Annual Meeting. P. S21.

Hines, O.S., J. R. Clark, R. T. Threlfall. 2015. Sensory Comparison of an Extremely Firm Fresh-market Blackberry Selection to Industry Cultivars. HortScience 49(9) (Supplement) – 2015 Southern Region-American Society for Horticulture Science Annual Meeting. P. S51.

Poster Presentations

Threlfall*, R.T., D.M. Segantini, and J.R. Clark. 2016. Descriptive Sensory Attributes of Arkansas Blackberries Harvested Multiple Years. American Society for Horticultural Science Annual Conference, August 8-11, Atlanta, GA. Poster #264

Threlfall, R.T., O.S. Hines, D.M. Segantini*, and J.R. Clark, 2015. Aromatic Impact of Fresh Blackberries Identified by a Descriptive Sensory Panel. American Society for Horticultural Science. New Orleans, LA, August 4-7, 2015.

Hines*, O.S., J. R. Clark, and R. T. Threlfall. 2015. Sensory Comparison of an Extremely Firm Fresh-market Blackberry Selection to Industry Cultivars. Southern Region-American Society for Horticulture Science Annual Meeting. January 30-February 1, Atlanta GA.

Oral Presentations

Threlfall*, R.T., D.M. Segantini, and J.R. Clark. 2016. Sensory and Composition Attributes of Arkansas Blackberry Cultivars. American Society for Horticultural Science Annual Conference, August 8-11, Atlanta, GA.

Threlfall,* R.T., O.S. Hines, J.R. Clark, and Segantini. 2016. Fresh-market Blackberries: What Consumers Want. University of Arkansas System Division of Agriculture Blackberry Workshop and Field Day. June 9. Clarksville, AR.

Threlfall*, R.T. O.S. Hines, and J.R. Clark. 2015. Commercial Attributes of Fresh Blackberries Identified by Sensory Panels. XI International Rubus and Ribes Symposium. June 21-24, Asheville, NC.

Threlfall*, R.T., O.S. Hines, and J.R. Clark. 2015. Investigating the Sensory Attributes of Blackberries. North American Raspberry and Blackberry Conference, February 24-27, Fayetteville, AR

Hines*, O. S., J. R. Clark, and R. T. Threlfall. 2015. Attributes of Fresh-Market Blackberries Identified by a Trained Descriptive Panel. Southern Region-American Society for Horticulture Science Annual Meeting. January 30-February 1, Atlanta GA.

Invited Presentation

Threlfall, R.T., J.R. Clark, and O.S. Hines. 2016. What Attributes Do Consumers Want in Fresh-market Blackberries? Southeast Regional Fruit and Vegetable Conference, January 7-10, 2016, Savanah, GA.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The impact of this research on pending and existing fresh-market blackberry genotypes is that the investigation will enable growers and producers in Arkansas and areas with similar growing conditions, to compete in the potential expansion of the fresh-market blackberry industry. The project will also increase consumer awareness of the potential benefits of buying and consuming nutraceutical-rich, fresh-market blackberries. Our contribution is data demonstrating the potential nutraceutical value and sensory characteristics of fruit from fresh-market blackberry genotypes, as well as farmer and consumer outreach. The research provided by this project is significant, because the knowledge gained from accessing blackberry fruit quality attributes from the new genotypes is expected to enhance blackberry production and market potential of blackberries grown in Arkansas. By providing data and materials to be used in marketing and promotion, we are helping to create a unique opportunity to boost consumer demand for fresh-market blackberries. This increased demand, along with expanding cultivar options and enhanced fruit quality will benefit blackberry growers.

It is estimated that at least 500 growers and researchers have benefited from this project through the dissemination of the results at horticulture conferences.

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

Our biggest challenge with this project was the unpredictability of working with fresh fruit and planning the sensory analysis. The work plan timeline was adjusted to accommodate the blackberry harvest season which began in late June 2014. We had an unexpected delay in the project because the honors student working on the project had to leave the project unfinished due to a critical family medical emergency. Dr. Howard's research technician completed the work on the nutraceutical analysis and Dr. Threlfall completed the statistical analysis and presentations from the 2014 data, but delayed the production of the published manuscript from 2014 data.

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Project 4: Muscadine Grape Postharvest and Antioxidant Research to Expand Fresh Market Muscadine Production in Arkansas

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

The muscadine grape, *Vitis rotundifolia*, is a southern native grape found from Arkansas eastward and throughout the deep south. The first varieties of muscadine, including the famous 'Scuppernong' were

wild vines which were propagated for commercial production. In the early 1900s, formal muscadine breeding was undertaken by the USDA in conjunction with North Carolina State University and by the University of Georgia. Other programs have also been active at times including those at the University of Florida and Florida A & M University along with the private program operated by Ison's Nursery in Georgia. The larger programs were most active from the 1940s to late 1980s. A number of improved varieties have developed from these efforts and these have served as the basis of the commercial production for fresh, juice, wine, and other uses. Only limited breeding has been done since the 1980s, however, and further improvements can be achieved to further expand muscadines as a fresh fruit choice.

Muscadine grapes are adapted to all but the extreme northwest corner of Arkansas, and are limited there by low winter temperatures. Although once commonly harvested from wild vines, improved varieties grown by farmers provide most of the fruit consumed currently. Muscadines offer a range of positive attributes. Foremost is that this is a native species, and has good to very high resistance to most diseases and insects that attack bunch grapes and can allow more sustainable production than their more common grape cousins which require 10-15 pesticide applications each growing season. Arkansans and southerners as a whole enjoy the very fruity flavor of muscadines, with a flavor profile much greater than most bunch grapes. The newer varieties (from the 1980s primarily) also have improved characters such as edible skins and a more desirable texture (crisper). Muscadines are a good source of antioxidants, another potential marketing attribute. A very limited number of varieties have been evaluated for some antioxidants such as resveratrol, ellagic acid and total phenolic compounds in North Carolina. Further research in Mississippi also indicated differences in muscadines sprayed with fungicides or not – with the non-sprayed vines producing fruit with higher levels of resveratrol. Finally, postharvest storage of important fresh market varieties and new selections would be valuable to determine the best varieties for storage and shipping for more distant markets or for holding fruit over a
longer period for local markets. The investigation of the variables could result in expanded production which could be marketed at the ever-increasing number of farmers markets, with on-farm sales, and potentially in retail grocery store outlets.

The University of Arkansas Division of Agriculture began its muscadine breeding program in 2005, one of several crops involved with the substantial fruit breeding program. This program has developed numerous selections thus far, with thousands more seedlings under evaluation for further selection. New varieties will be forthcoming from this effort for Arkansas growers in the future.
The project purpose/objective is to evaluate existing varieties and new selection developments for postharvest storage potential along with determination of antioxidant levels. This knowledge will expand information for growers in variety selection for a range of markets, and provide information on the very desirable antioxidant levels of fresh-market genotypes (a genotype is either a breeding selection or a variety). Supporting funding from the Arkansas Department of Agriculture along with Division resources provide a very viable partnership with a high level of potential success.
This report provides the work done for the project year 2013 when the studies outlined were fully done and completed as described in the original proposal.

The University of Arkansas Division of Agriculture began its fruit breeding program in 1964. This effort has been one of the most productive fruit breeding efforts in the United States in recent years. More than 60 varieties of fruits have been commercialized from the program, including blackberries, table grapes, peaches, nectarines, strawberries, and blueberries. These variety options have expanded fruit potential for Arkansas growers allowing enhanced profitability. The newest variety development effort was begun in 2005 focusing on fresh-market muscadines. Reasons to begin this endeavor included a potential for muscadine production in the State, Division personnel with training and experience to successfully carry out research activities, and a potential to make some substantial genetic improvements in muscadine postharvest quality. For muscadine production to increase for the fresh market, enhanced postharvest handling information on released varieties is needed, along with the measurements of potential new

varieties among the developed selections from the breeding program. Information on what are the most important postharvest characteristics in storage is needed to fully proceed with developing a system for postharvest evaluation. It is timely because now there are several new varieties developed in recent years that need evaluation along with the new selections just developed by the University of Arkansas.

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

Time Line: September 2013-August 2014 (*note:* Since Muscadines generally ripen from August to October; the project will be initiated in August.)

The work was completed as proposed. No changes were made in the work plan. The growing season in 2013 was considered more normal than that of 2012 which was unusually hot and dry. Substantial differences were observed in minimum and maximum temperatures as well as for precipitation among the years of the study. During the growing and harvest seasons (April through September) differences of mean temperatures up to 5°C warmer, and approximately half as much precipitation was observed in 2012 compared to 2013. These extreme differences in weather among years of the study offered some important insight on the significance of environment on postharvest storage and composition of muscadine grapes.

August-September 2013: PD Clark will monitor the muscadines to determine harvest. A University of Arkansas M.S. graduate student (supervised by PD Clark) will implement this project as part of thesis research. Grapes will be harvested and transported to the University of Arkansas Food Science Department. Co-PI Threlfall will supervise the student in the postharvest evaluation and composition analysis. The muscadines will be stored for four weeks and evaluated weekly. The student will perform the analysis for composition and post-harvest evaluation with assistance as needed from other University of Arkansas staff.

Complete Materials and Methods
Vines of 17muscadine genotypes used for the study were grown at the University of Arkansas Fruit Research Station, Clarksville, AR (lat. 35°31’58’N and long. 93°24’12’W). Vines were of varying ages within each genotype, most of the cultivars were approximately six years old, while many of the selections were from younger vines three to four years old. The vines were grown in Linker fine sandy loam, in USDA hardiness zone 7a, where average annual minimum temperatures reach -15 – 17.7 °C. Vines were spaced 6.1 m apart and rows were spaced 3.0 m apart. A single-wire trellis was used, and vines were trained to a bilateral cordon. The vines were dormant pruned annually in February using spur pruning with spurs retained of two to four buds in length. Weeds were controlled with pre- and post-emergence herbicides as needed, and vines did not have any stress from weed competition. Vines were irrigated by drip irrigation as needed, beginning in early June (prior months received adequate rainfall) and continuing through the harvest period. Vines received N fertilization in March of each year at a rate of approximately 70 kg ha-1. No insecticides or other pest control compounds were applied to the vines, other than those vines that received the fungicide treatments (see below). The vines used in the study had full crops produced each year, and no crop reduction due to winter injury or other limitation occurred. Thus, the vines produced fruit under representative conditions. Daily maximum and minimum temperatures along with rainfall were recorded at the research location to characterize the environment the vines were subjected to and potential differences among years.

The vines of nine muscadine cultivars and selections were used for fungicide treatments. Each genotype had a single vine treated with fungicide, while the other did not receive fungicide applications (berries from the fungicide-treated vines were referred to as fungicide-treated berries and berries from the no fungicide-treated vines were referred to as no fungicide-treated berries). A rotation of systemic field fungicide applications of Abound® (azoxystrobin: methyl (E)-2-{2-[6-(2-cyanophenoxy) pyrimidin-4-yloxy] phenyl}-3-methoxyacrylate*) and Rally® (myclobutanil: a-butyl-a-(4-chlorophenyl)-1H-1,2,4,triazole-1-propanenitrile) (a sterol inhibitor) were applied with a backpack sprayer every 14 d beginning when the fruit was approximately 3-5 mm in diameter and after approximately 400 growing degree units were accumulated beginning 1 Jan.

The muscadines were once over, hand-harvested. Harvest date/maturity was based on soluble solids (SS) of 18-22%,, ease of release from the pedicel, and berry color. Both fungicide treated and non-fungicide treated vines within the same genotype were harvested on the same day. Fruit was harvested either early in the morning or late in the afternoon and transported to the University of Arkansas Institute of Food Science and Engineering, Fayetteville, AR., in an air-conditioned car on the same day. The fruit was stored at 2°C upon arrival.

October 2013-February 2014: Co-PI Howard will supervise the student in the nutraceutical analysis. The student will plan and implement the nutraceutical analysis from fruit sampled and frozen during the initial phases of the project.

Berries were then hand-sorted to remove any split, shriveled, or decayed fruit before packaging to simulate commercial standards. Only sound berries, showing no signs of unmarketability, were used for this study. The fruit was packaged into hinged standard vented clamshells (18.4 cm x 12.1 cm x 8.9 cm) (H116, FormTex Plastics Corporation, Houston, TX) and placed in cold storage at 2°C with 85-89% RH. From the randomly selected fruit from each vine, six vented clamshell containers were filled to approximately 500 g.

Three of these clamshells were used as storage replications for each treatment and genotype. Total clamshell weight was determined at date of harvest, and percent weight loss was calculated as percent weight decrease from this initial value. Weight loss and percent unmarketable fruit were evaluated on the storage clamshells every 7 d for up to 21 d. Storage performance was evaluated by removing all the fruit from each clamshell and counting the number of fruit that showed signs of unmarketability, which included individual or a combination of characteristics of browning, softness, mold, rot, leakage, splitting, and shriveling. Both the unmarketable and marketable berries were returned to the appropriate clamshell each week, and storage measurements were discontinued once the percent unmarketable in all three clamshells reached 50%, or after 3 weeks of storage.

The remaining three clamshells were used as replications for physicochemical analyses. For physicochemical measurements, every 7 d three berries were removed from each of the three clamshells and used to measure berry volume, Chroma, hue, L*, SS, titratable acidity (TA), pH, and firmness of the skin and flesh. Physicochemical measurements were discontinued once the percent unmarketable in all three clamshells reached 50% or after 3 weeks of storage.

Titratable acidity and pH were measured by an 877 Titrino Plus (Metrohm AG, Herisau Switzerland) with an automated titrimeter and electrode standardized to pH 2.0, 4.0, 7.0, and 10.0 buffers. Titratable acidity was determined using 6 g of juice diluted with 50 mL of deionized, degassed water by titration of 0.1 N sodium hydroxide (NaOH) to an endpoint of pH 8.2, with results expressed as percent tartaric acid.

Soluble solids were measured using a Bausch and Lomb, Inc. Abbe Mark II refractometer (Rochester, NY). Soluble solids, TA, and pH were measured from the juice of the whole berries, strained through cheesecloth to remove any solids.

Exterior skin color measurements were determined on each of the three berries every 7 d using a Chroma Meter CR 300 series (Konica Minolta Holdings Inc., Ramsey, NJ). The Commission Internationale de I'Eclairage (CIE) Lab transmission "L*" value indicates how dark or light the skin is, with 0 being black and 100 being white. Hue angle describes color in angles from 0° to 360°: 0° = red; 90° = yellow; 180° = green; 270° = blue; and 360° = back to red. Chroma is the aspect of color by which the skin colors appears different from gray of the same lightness and corresponds to intensity of the perceived color. Firmness, or the maximum force to penetrate skin and flesh tissues, was determined using the three whole berries per replication. A TA-XT2 Texture Analyzer (Stable Micro Systems, Haslemere, UK) with a 2-mm-diameter probe was used to penetrate the skin and mesocarp tissues (flesh) to a depth of 10 mm in each berry at a rate of 10 mm.s-1. Measurements are expressed as force in Newtons (N), and the data was analyzed using Texture Expert Version 1.17 (Texture Technologies Corp., Scarsdale, NY).
Three randomly selected berries from each physicochemical replication of each treatment were used from the harvest date sample to measure nutraceuticals including oxygen radical absorbance capacity (ORAC), and levels of total phenolics, total anthocyanins, total ellagitannins, total flavonols, and resveratrol.

The storage experiment was designed as a split plot with three replications of each genotype and fungicide treatment. The split was storage (weeks 0, 1, 2, and 3). The nutraceutical component was a complete randomized design with three replications of each genotype and treatment, (these measurements were only done on the harvest date, not during storage. A single vine was used as an experimental unit. The data were analyzed by analysis of variance (ANOVA) using JMP® (version 11.0; SAS Institute Inc., Cary, NC). Tukey's Honest Significant Difference and Student's t Test was used for mean separations ($p = 0.05$). Associations among all dependent variables were determined using multivariate pairwise correlation coefficients of the mean values using JMP® (version 11.0; SAS Institute Inc., Cary, NC).

March-May 2014: Working with a University of Arkansas statistician, the graduate student will statically analyze the data and incorporate the new work into the thesis. The student will also prepare abstracts on the research project for submission to attend conferences and present the findings. The student is projected to complete his MS thesis including results of this project in May, 2014.

The results below provide 2013 results along with comparisons to 2012 results (the first year of funding for this research topic by the SCBG program).

Muscadine Vines Not Sprayed With Fungicides

As in 2012, again in 2013 the physiochemical and storability attributes were measured in 17 muscadine genotypes (selections and varieties) from the muscadine breeding program at the University of Arkansas or commercial varieties. The fruit of the vines in this portion of the study were not sprayed with any fungicides during the growing season. The postharvest and physiochemical attributes of the muscadines were measured at harvest and during storage for 3 weeks at 2°C. Nutraceutical compounds were measured initially after harvest.

Overall results showed generally the same major findings in 2013 compared to 2012. The genotypes significantly affected storage attributes (weight loss (%), and unmarketable berries (%) and physiochemical attributes such as penetration force (force to penetrate berry skin), titratable acidity (TA), pH, soluble solids (%), berry color (L*, Chroma, and hue), as well as the nutraceutical compounds. The postharvest attributes of weight loss and unmarketable berries and the physiochemical attribute of penetration force were significantly affected by postharvest storage, but berry composition attributes remained fairly constant during storage.

In more detail the results for specifically for 2013 and often compared to 2012 follow. The performance of the genotypes varied by year. After 3 weeks of storage, the genotypes with the least percent weight loss in 2013 were AM 28, 'Southern Jewel', and 'Nesbitt' (2.2, 1.9, 2.0%, respectively), while in 2012 AM 27, AM 03, 'Delicious', and 'Tara' had the least (4.3, 4.5, 4.7, and 4.7%, respectively) (Fig. 1). The genotypes with the greatest percent weight loss after 3 weeks of storage in 2013 were AM 03, AM 01, and 'Fry' (4.2, 4.1, and 4.1% respectively), while in 2012 'Nesbitt', AM 04, and AM 18 had the greatest weight loss (6.5, 6.2, 5.9%, respectively) (Fig. 1). In 2013, the genotypes with the least percent unmarketable berries after 3 weeks of storage were AM 26, AM 28, AM 04, and AM 03, (8.9, 11.8, 12.6, 18.5%, respectively), while in 2012 AM 03, 'Summit', 'Southern Jewel', and 'Supreme' had the least percent unmarketable berries (15.3, 20.7, 23.2, and 24.1%, respectively) (Fig. 2). The genotypes in 2013 with the highest percent unmarketable berries were AM 01, Fry, and Tara (94.9, 73.9, and 70.5%, respectively), while in 2012 the genotypes with the highest percent unmarketable berries were 'Fry', AM 04, and AM 26 (65.8, 64.8, 60.7%, respectively) (Fig. 2). This shows the impact of environmental factors (rainfall and temperature) on storage performance of muscadines and the importance of multiple year evaluations.

Unmarketability of muscadines was primarily due to browning (especially in bronze genotypes), leakage from torn or wet stem scars, and shriveling. The browning of the bronze berries (especially AM 01 in 2013) was likely caused by chilling injury. This abiotic disorder is common in many horticultural crops and can increase susceptibility to decay by providing media for the growth of pathogens. The primary symptom of chilling injury identified in this study was brown discoloration of the skin, pulp, and vascular strands of fruit. Although chilling injury has been reported in muscadines stored at 1.7°C or below, chilling injury is not usually observed in muscadine grapes stored at 2-3°C. Leakage and shriveling were also common causes of unmarketability during storage, but can be managed by removing berries with wet stem scars prior to storage and maintaining high RH during storage. In general, during storage for 3 weeks at 2°C, the black genotypes had a 39% increase in unmarketable fruit, and the bronze genotypes had a 48% increase.

Force to penetrate muscadine skin has been shown to be a useful characteristic to assess berry firmness and texture as well as berry quality. Muscadines require a force up to 13.9 N to penetrate the skin at date of harvest, which is nearly twice that of standard table grape (*V. vinifera*) cultivars. Similarly, we found that 'Nesbitt' had among the highest penetration force, requiring up to 13.2 N to penetrate the skin at date of harvest in 2013. Berries stored in 2013 were generally firmer than in 2012 (Fig. 3). In 2013, penetration force ranged from 13.2 N ('Nesbitt' at week 0) to 3.3 N ('Tara' at week 3), while in 2012 penetration force ranged from 10.4 N (AM 28 at week 0) to 1.8 N (Tara at week 2) (Fig. 3). Percent unmarketable berries was negatively correlated with force (r=-0.74), potentially illustrating that berries requiring greater force to penetrate the berry skin store better as they were firmer and likely this is one of the more important relationships among variables measured to assist in evaluating a genotype's postharvest storage potential. Overall, berry penetration force decreased during storage, but was occasionally lowest after 2 weeks of storage (Fig. 3), and this could possibly be due to water loss during storage. It was found that the genotypes requiring the most force to penetrate the skin at date of harvest also required the most force to penetrate the skin after 3 weeks of storage (especially in 2013) (Fig. 3), indicating force is a good indicator of storage performance. In general, during storage for 3 weeks at 2 °C,

the black genotypes had a 30% reduction in penetration force, and the bronze genotypes had a 36% reduction in penetration force.

Titratable acidity, pH, and soluble solids remained relatively constant during storage (data not shown). The percent soluble solids were uncharacteristically higher in 2012, while TA was uncharacteristically low in 2013. In 2012, AM 04 had the highest percent TA (0.60%), while AM 03 and AM 18 had the lowest values (0.29 and 0.26%, respectively). In 2013 AM 01 and 'Delicious' had the highest TA (0.45%) and AM 28 had the lowest value (0.23%). Berry pH ranged from 3.25 ('Ison') to 3.83 (AM 04) in 2012 and from 3.40 (AM 15) to 3.96 (AM 02) in 2013.

The effect of storage on the exterior berry color attributes (L* value, Chroma, and hue angle) of muscadine grapes is widely unstudied. The United States Department of Agriculture (USDA) has no standards available to grade muscadine berries for L* value, Chroma, and hue angle. The standards for exterior berry color of muscadines state the berries should be well colored to be considered marketable; for black and red cultivars 75% of the surface of the berry must have characteristic color for the variety, while no color requirement exists for bronze genotypes except that for 'Carlos', 'Fry', or similar varieties can show any amount of blush or bronze color on the berry. Additionally the USDA states that black variety colors can include reddish purple, purple, and black; red variety colors include light pink, pink, red, dark red, and purple; and bronze variety colors include light green, straw, amber, and bronze with allowance for an amount of blush or pink color that may also be characteristic for certain varieties. L* values were generally greater for the bronze genotypes compared to the black genotypes and were often greater in 2013 compared to 2012. L* values ranged from 45.2 (AM 03) to 26.3 (AM 02) in 2012 and from 91.2 (AM 01) to 25.1 (AM 04) in 2013. There was a negative correlation between hue angle and L* value (r=-0.80), showing that as L* increased (berries became lighter), hue angle decreased. Hue angles were generally higher for the black genotypes compared to the bronze genotypes and similar to L*, were generally greater in 2013 compared to 2012. This difference in exterior color among years might be due to less berry sunburn in 2012 as compared to 2013. A positive correlation was observed among L* and soluble solids (r=0.71), indicating L* could be used as a ripeness indicator. In 2012, hue angles ranged from 359.4° ('Supreme') to 54.0° ('Summit'), while in 2013 hue angles ranged from 349.5° (AM 28) to 90.6° (AM 26). Chroma values were generally higher in 2012 than in 2013. In 2012, AM 03 had the highest Chroma (17.9) and AM 27 and 'Delicious' had the lowest (2.6 and 2.3, respectively), while in 2013 'Fry' had the highest Chroma (14.1) and AM 18 and AM 27 had the lowest (2.1 and 2.0, respectively). There was a strong negative correlation between Chroma and hue angle (r=-0.93) and a positive correlation between Chroma and L* (r=0.72). In general during storage for 3 weeks at 2 °C, the black genotypes had a 25% reduction in L* and 36% reduction in Chroma, while the bronze genotypes had a 20% reduction in L* and 36% reduction in Chroma.

In both 2012 and 2013, the black genotype AM 27 had the highest anthocyanins (122.0 and 41.8 mg/100 g, respectively), but as expected no anthocyanins were detected in the bronze genotypes. Total anthocyanin concentrations in the black genotypes were generally higher in 2012 than in 2013 (average values of 68.1 and 32.2 mg/100 g for 2012 and 2013, respectively). A negative correlation with total anthocyanins and Chroma (r=-0.87) and a positive correlation with hue angle (r=0.75) was found, showing that lower Chroma values and greater hue angles were related to higher total anthocyanins, which was not surprising as bronze genotypes generally had higher Chroma values and lower hue angles and no anthocyanins. Black genotypes had an average total anthocyanin concentration of 501.2 mg/100g.

Total ellagitannin concentration was slightly higher in 2013 compared to 2012. In 2012, total ellagitannins ranged from 1.6 ('Supreme') to 12.4 mg/100 g ('Ison') and from 4.0 (AM 01) to 12.8 mg/100 g (AM 03) in 2013. Black and bronze genotypes had average total ellagitannin concentrations of 6.8 and 7.2 mg/100g, respectively.

Oxygen radical absorbance capacity (ORAC) is widely accepted as being a good estimation of antioxidant capacity of fruits, although its significance is often questioned, as it does not accurately represent the bioactivity of the antioxidants in the human body. We found ORAC values that ranged from 47.7 ('Tara') to 110.6 ('Ison') μmol TE/g in 2012, and from 53.5 (AM 03) to 115.5 μmol TE/g ('Ison') in 2013. ORAC values were found to be higher in 2013 compared to 2012. The cultivar Ison had the highest ORAC values both years of the study, while 'Supreme' and 'Tara' had among the lowest both years. Black and bronze genotypes had average ORAC values of 82.3 and 68.2 μmol TE/g, respectively.

Generally, genotypes differed in total flavonol concentration among years, with the exceptions of AM 15 and 'Summit', which had among the highest concentration both years of this study. Total flavonols ranged from 7.3 ('Supreme') to 70.6 mg/100 g (AM 03) in 2012, while in 2013 total flavonols ranged from 9.9 (AM 28) to 47.9 mg/100 g). The bronze genotypes were generally higher in total flavonols than the darker genotypes, which may be attributed to the presence of the flavonol myricetin in the bronze genotypes. A positive correlation with total flavonols and soluble solids (r=0.73) and a negative correlation with hue angle and total flavonols (r=-0.73) occurred. These correlations possibly illustrate that riper berries have higher flavonol concentrations, as soluble solids has been shown to be an indicator of muscadine berry ripeness and berries with lower hue angles had higher total flavonols, which is supported by the data as the bronze genotypes generally had higher total flavonol levels and lower hue angles. Black and bronze genotypes had average total flavonol concentrations of 15.9 and 32.6 mg/100 g, respectively.

Total phenolic concentrations were generally higher in 2012, compared to 2013, likely due to the added stress on the vines from hot and dry growing conditions, and the plants responding with increased phenolic production. In 2012, total phenolics ranged from 354.5 (AM 28) to 797.3 mg/100 g ('Ison') and in 2013 total phenolics ranged from 316.9 (AM 28) to 606.7 mg/100 g ('Delicious'). We found 'Summit' to have among the highest levels of total phenolics while 'Supreme' had among the lowest total phenolics of the genotypes measured. Total phenolics were positively correlated to ORAC (r=0.78). Black and bronze genotypes had average total phenolic concentrations of 507.4 and 533.5 mg/100g, respectively. Resveratrol concentrations were similar both years of the study. Resveratrol ranged from 3.8 (AM 02) to 16.7 mg/100 g (AM 27) in 2012, while in 2013, resveratrol ranged from 2.9 (AM 28) to 12.1 mg/100 g ('Supreme'). No clear relationship between berry color and resveratrol concentration was found. Overall, AM 03, AM 04, AM 27, and 'Ison' had the highest nutraceutical content (total anthocyanins, total ellagitannins, total phenolics, total flavonols, resveratrol, and ORAC), while AM 18, AM 28, 'Supreme', and 'Tara' had the lowest content.

Comparison of Vines Sprayed or Not Sprayed with Fungicides

There were two field treatments (no fungicide and fungicide). For the fungicide treatment, alternating applications of two fungicides were applied to the vine at 14-d intervals during berry maturation. Fruit was harvested and physicochemical attributes including berry volume, titratable acidity (TA), pH, soluble solids (%), color (L, Chroma, and hue), firmness (force to penetrate berry skins and flesh), storage weight loss (%), and unmarketable fruit (%) were evaluated every 7 d for 3 weeks. Whole muscadine berries were analyzed for nutraceutical content only for the date of harvest.

The overall results for the two years, including 2013, from the sprayed compared to non-sprayed vines, showed these major findings. The postharvest fruit diseases present were identified as black rot (*Guignardia [Phyllosticta] bidwellii [ampelicida]* Ellis.), myrothecium leaf spot (*Myrothecium* sp./spp.), and botrytis fruit rot (*Botrytis* sp./spp.). Generally, fruit diseases were not a major cause of unmarketability for either fungicide or no fungicide treatments, until 3 weeks of storage. The primary factors involved in unmarketable fruit were browning (especially in bronze genotypes), leakage from torn or wet stem scars, and shriveling. After 3 weeks of storage, AM 15 fungicide-treated berries in 2012 and 'Nesbitt' no fungicide-treated fruit in 2012 had the greatest weight loss (7.1 and 6.5 %, respectively),

while ‘Nesbitt’ and ‘Southern Jewel’ from all treatments in 2013 each had the least weight loss (2.2 %) (data not shown). AM 01 no fungicide-treated berries in 2013 and ‘Nesbitt’ fungicide-treated fruit in 2012 had the greatest amount of unmarketable berries after 3 weeks of storage (94.9% and 81.7%, respectively), while AM 04 fungicide- and no fungicide-treated berries in 2013 and ‘Summit’ fungicide-treated berries in 2012 had the least amount of unmarketable berries after 3 weeks (12.6% and 14.5%, respectively). Overall, berries from fungicide treatments had less unmarketable berries, but treatment had much less effect on weight loss compared to genotype.

After 3 weeks of storage, fungicide- and no fungicide-treated berries of ‘Tara’ had the lowest force (3.2 and 3.3 N in 2012 and 5.45 and 4.8 N in 2013, respectively), while fungicide- and no fungicide-treated berries of AM 04 had the highest (7.8 and 7.7 N in 2012 and 9.8 and 9.5 N in 2013, respectively). Berries stored in 2013 were generally firmer than the berries stored in 2012, further showing the significance of environmental influences on storage quality with heat stress likely contributing to less firm berries. Though fungicide-treated berries were often more firm, genotype and year were much more influential on berry firmness.

Overall, berry physicochemical attributes were found not to significantly change during storage from sprayed or unsprayed vines, either year of the study (data not shown), and are not discussed further in this report. The lack of differences in week, year, and fungicide treatment indicated that genotype was the greatest contributor as a source of variation for physicochemical attributes. Also, fungicide treatments had no effect on L*, hue or Chroma.

In 2012, fungicide-treated AM 04 and no fungicide-treated AM 27 had the highest anthocyanin concentrations (127.8 and 122.0 mg/100 g, respectively), while in 2013 fungicide-treated ‘Nesbitt’ had the highest concentration (49.4 mg/100 g). Anthocyanin concentrations were generally higher in 2012 than in 2013 with the exceptions of no fungicide-treated ‘Nesbitt’ and ‘Supreme’, and fungicide-treated ‘Southern Jewel’ (Table 3). The differences in total anthocyanins among years may be due to higher temperature and greater sun exposure and therefore greater color development and anthocyanin concentration in the 2012 growing season. Fungicide treatments did not consistently affect total anthocyanin concentrations either year of the study.

Total ellagitannins were higher in 2013 than in 2012, with fungicide-treated ‘Summit’ having the highest levels both years of the study (14.1 in 2012 and 13.1 mg/100 g in 2013), while fungicide-treated ‘Supreme’ had the lowest level in 2012 (0.6 mg/100 g) and no fungicide-treated AM 01 had the lowest level in 2013 (4.0 mg/100 g). Ellagitannin concentrations varied greatly among genotypes and treatments with no consistent effect of fungicide treatments.

In 2012 and in 2013, fungicide-treated AM 27 had the highest ORAC levels (125.3 and 119.0 μmol TE/g, respectively), while fungicide-treated ‘Supreme’ in 2012 (56.6 μmol TE/g) and no fungicide-treated ‘Tara’ had the lowest ORAC levels in 2013 (47.7 μmol TE/g). Overall, the berries from fungicide-treated vines had higher ORAC values than those from no fungicide-treated vines, though variation did occur among genotypes.

In 2012, no fungicide-treated ‘Summit’ and no fungicide-treated AM 15 in 2013 had the highest total flavonols (63.1 and 47.9 mg/100 g, respectively) and fungicide-treated ‘Supreme’ has the lowest concentration in both 2012 and 2013 (5.0 and 8.4 mg/100 g, respectively). Total flavonol concentrations were higher for the fungicide-treated fruit overall, although this varied among genotypes and years.
In 2012, total phenolics were higher for the fungicide treatment, while in 2013 no differences were found among fungicide treatments. In 2012 total phenolic concentrations ranged from 812.7 mg/100 g (fungicide-treated AM 27) to 366.1 mg/100 g (no fungicide-treated ‘Supreme’), while in 2013 they ranged from 655.9 mg/100 g (fungicide-treated ‘Southern Jewel’) to 315.5 (fungicide-treated ‘Supreme’).

In 2012, no fungicide-treated AM 17 had the highest resveratrol concentration (16.7 mg/100 g) and fungicide-treated 'Supreme' had the lowest (2.9 mg/100 g), while in 2013 no fungicide-treated 'Supreme' had the highest resveratrol concentration (12.1 mg/100 g), while no fungicide-treated 'Southern Jewel' had the lowest (3.2 mg/100 g). In 2012, no differences were found among fungicide treatments, while in 2013 the no fungicide-treated fruit had higher levels of resveratrol than the fungicide-treated fruit. The differences in fungicide treatment among years could be due to the hot and dry conditions during the growing season of 2012, as resveratrol can be produced in response to fungal infection, which occurs more readily in cooler, wetter conditions.

Protocol Development
From this work, one of the key findings was a the determination of a storage protocol to use to evaluate the most important variables that impact storage potential and shelf life of muscadines.

Protocol for Arkansas Muscadine Postharvest Cold-Storage Evaluation

General:
This protocol was developed for the standardized evaluation of cold-storage performance of muscadine genotypes. To simulate commercial conditions, four replications of approximately 500 g clamshells should be obtained from a once over harvested vine. Two of these clamshells will be for storage attributes, while two will be used for composition attributes.

Harvest:
Vines should be once over hand-harvested when the majority of the fruit is fully colored, after some berry drop has occurred, and berry soluble solids of 16-22% (usually August-October), to simulate commercial standards. Knowing when to harvest is more subjective than objective and takes a while to get comfortable with. Handle all fruit gently and use only clean harvesting and storage equipment. Muscadine can be harvested into yellow harvest lugs, by holding the lugs beneath the vine and "tickling" the berries. The fully ripe berries will readily abscise from the vine and fall into the lug. The lug should be held as close as possible to the vine to prevent damage to the berries. The harvested fruit should be kept in the shade during harvest, and moved to cold storage as soon as possible.

Cold storage parameters:
Prior to placing the berries into clamshells and into cold storage, all damaged, diseased, torn, and off colored (green/pink or purple or dark brown for bronze genotypes) should be removed. The four clamshells should be randomly filled with high quality berries. To simulate commercial conditions, place the filled clamshells into harvest lugs lined with paper towels. Ideal conditions for muscadine cold storage is 2-3 °C and 85-95% relative humidity (RH).

Initial evaluation (week 0):
Storage clamshells: At this point the initial measurements of total berry number per clamshell, number of berries with wet stem scars, and total weight per rep (minus clamshell weight) should be taken.
Composition clamshells: Five randomly selected berries from each composition clamshell should be removed and measurements of skin L*, skin Chroma, skin hue angle, force of berry flesh, whole berry firmness, soluble solids, pH, and titratable acidity (TA) should be taken.

1. Exterior skin color measurements can determined on each of the five berries using a Chroma Meter CR 300 series (Konica Minolta Holdings Inc., Ramsey, N J).

2. Firmness can be evaluated with a TA-XT2 Texture Analyzer (Stable Micro Systems, Haslemere, UK) equipped with a 2-mm-diameter flat-tip probe used to penetrate the exocarp and mesocarp tissues (flesh). Measurements were expressed as force in Newtons (N). and the data was analyzed using Texture Expert Version 1.17 (Texture Technologies Corp., Scarsdale, NY).

• Whole berry firmness was measured by penetration to a depth of 10 mm in each berry at a rate of 10 mm.s-1.

• Flesh texture was examined by carefully removing the skin of the berry on the equatorial plane of the berry with a razor blade revealing a 1-cm circular area of flesh and penetration the exposed berry flesh to a depth of 3 mm at a rate of 10 mm.s^{-1}.

*Note: The texture analyzer program will need to be adjusted and new macros written for this protocol.

3. Soluble solids, TA, and pH are measured from the bulk juice (extracted by hand squeezing) of the five whole berries, strained through cheesecloth to remove any solids. Titratable acidity and pH can be measured by an 877 Titrino Plus (Metrohm AG, Herisau Switzerland) with an automated titrimeter and electrode standardized to pH 2.0, 4.0, 7.0, and 10.0 buffers. Titratable acidity should determine using 6 g of juice diluted with 50 mL of deionized, degassed water by titration of 0.1 N sodium hydroxide (NaOH) to an endpoint of pH 8.2, and results should expressed as percent tartaric acid. Soluble solids should be measured using a Bausch and Lomb Inc. Abbe Mark II refractometer (Rochester, NY).

Storage evaluation (weeks 1, 2, 3, and 4):

Storage clamshells: At this point weight loss should be measured, as well as the berries showing signs of unmarketability (fungal grow, leakage, shriveling, and discoloration [browning or darkening is most common]) should be counted from each clamshell.
Composition clamshells: Five randomly selected berries from each composition clamshell should be removed and measurements of skin L*, force of berry flesh, whole berry firmness should be taken. All other composition measurements should be discontinued, as they generally do not change during storage.

Storage evaluation can be discontinued after the clamshells have <35 unmarketability, which is usually around 3 week of storage.

June-July 2014: Dr. Clark and/or the graduate student will present the data at conferences/workshops/field days through either oral or poster presentations.

Major Accomplishments and Conclusions
From this work, there are a few accomplishments and comments to be made from the single-year's data:
-Overall, University of Arkansas selections AM 04, AM 26, AM 28, and the variety Southern Jewel had the highest potential for postharvest storage, while the genotypes AM 01, AM 15, AM 18, and 'Nesbitt' had the least potential. This information is useful as growers consider varieties to consider particularly for longer-term storage of fruit for marketing.

- Overall, both percent unmarketable berries and percent weight loss increased during storage, showing importance as storage parameters. Force to penetrate the berry skin generally decreased during storage, also showing potential as an important postharvest storage parameter, particularly since some genotypes had significantly less reduction in force during storage. Physiochemical parameters TA, pH, and soluble solids remained relatively constant during storage, therefore are not important postharvest storage

measurements to routinely use in evaluating storage potential. The berry color measurements, L*, Chroma and hue angle, generally showed no clear pattern during storage.

-Generally, the bronze muscadines were visually darker, decayed more, and softened during storage, indicating particular care must be exercised in handling this color of fruit.

-The differences among years for many dependent variables indicated the importance of multi-year evaluations of breeding selections for storage potential.

-Effects of fungicides overall were less than anticipated overall.

-Many new nutraceutical measurements were made, and show interesting results for the many genotypes and compound studied. Muscadines were confirmed as a very good source of antioxidants, and the varieties and selections varied substantially for these measured compounds.

- A storage protocol was developed to use in evaluation of new varieties and selections in the Arkansas breeding program, and this will greatly assist in the identification of the best storage potential new varieties for release to growers.

Muscadine Workshop

Another significant activity for the year was a grower workshop to share about the studies and muscadine grape postharvest information and production. This workshop was held September 11 and had 56 people in attendance, a very good turnout for the second of these meetings (one was held in 2012). The meeting was held at the Univ. of Arkansas Fruit Research Station, Clarksville. The program follows:

Muscadine Workshop and Field Day

University of Arkansas
Fruit Research Station
Clarksville, AR
Thursday, September 11, 2014
2:30-7:30 pm
Registration cost is $25.00

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Agenda

2:30-3:00 pm	**Registration and View Fruit Display**
3:00-3:15 pm	**Welcome**
	Dr. John Clark , Dr. Elena Garcia, and Dr. Renee Threlfall, University of Arkansas
3:15-4:00 pm	**Advances in Muscadine Breeding Efforts at the University of Georgia**
	Dr. Patrick Conner, Associate Professor, University of Georgia
4:00-4:30 pm	**Production of Muscadine Grapes**
	Elena Garcia, Extension Fruit Specialist, University of Arkansas
4:30-5:15 pm	**Growing and Shipping Fresh-market Muscadine Grapes in North Carolina**
	Ervin Lineberger, Owner, Lineberger's Killdeer Farm, North Carolina
5:15-5:30 pm	**Update on Muscadine Postharvest Research Project**
	Dr. Renee Threlfall, Research Scientist, University of Arkansas
5:30-6:30 pm	**Catered Dinner**
6:30-7:30 pm	**Vineyard Tour of the University of Arkansas Muscadine Breeding Program**
	Dr. John Clark , University Professor, University of Arkansas

Registration

The registration fee for this workshop is $25.00. Registration and payment deadline is **Thursday, August 28, 2014.** For online registration and payment information click here or visit http://uark.edu/ua/afls1234/webforms/muscadine_workshopcashnetjm.php

For registration information contact or make the check payable to the University of Arkansas and send the check with the form to:

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ARKANSAS AGRICULTURE DEPARTMENT

This workshop is partially funded by the Arkansas Agriculture Department Specialty Crop Block Grant Program.

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This program brought in two experts on muscadines. One was a grower, Mr. Lineberger, who is one of the most experienced in the world on growing and shipping muscadines for the fresh market. Dr Patrick Conner leads one of the oldest muscadine breeding efforts in the world, and gave comments on new varieties and their storage potential. Dr. Threlfall provided findings from the SCBG-funded research included in this report. The workshop was rated very positively by participants.

Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

Detail the significant contributions and role of project partners in the project.

The project leader (John R Clark) led this funded effort in his role as project leader and University Professor in the Division of Agriculture. He outlined the overall studies, directed the MS graduate student, provided guidelines for the management of the vines used, and was involved in data collection and conclusions. He played a major role in planning for the workshop also as well as providing a tour of the UA breeding program at the workshop. Dr. Renee Threlfall played a very integral role in managing analytical aspects of the project, and managed the laboratories and the MS student that carried out the laboratory work. She also played a major role in data analysis and results interpretation. She was a key planner along with carrying out many aspects of the workshop and presenting results of the funded research. Derek Barchenger was the MS student in the Dept. of Horticulture that conducted the research work. He was funded by a Department assistantship. He did work at the Fruit Research Station (where the fruit was produced) and in laboratories at the Dept. of Food Science. He completed his MS degree in May of 2014 with this research reported here as a major portion of his thesis.

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.
- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

The activities undertaken were fully described above. The field and laboratory work, data analysis, reporting, and overall conclusions of the work were completed as proposed. The measurable outcomes are fully described above also.

This work resulted from two single-year proposals, with overall results reported here from the two years of data. Developing a muscadine variety is a long term process, and this work contributed to this process as the breeding program moves forward with testing of developed selections for potential cultivar release in addition to using this information of new developments now and the coming years.

All goals were accomplished as outlined in the proposal and reporting in this final report.

As described above all activities proposed were carried out. Results described above report data collected, data results and interpretation, and the primary overall findings of the work. The sharing with the public in a workshop was achieved also as proposed. Many, many components of the proposed work came together to make this project a complete success as proposed. The MS student Mr. Barchenger was an outstanding person to carry out the majority of the work, the weather cooperated, a good crop of fruit was achieved each year, and the results provided very good conclusions. Excellent progress was made.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The intended beneficiaries were primarily twofold: growers and ultimately consumers. The initial beneficiary, the grower, will benefit from this project by from receiving information on selected varieties of muscadines that performed well in storage (or did not). This was conveyed in the workshop, or in other communications from this work. Growers also benefitted from the workshop as additional topics on muscadine production were shared and discussed, all leading to an enhanced knowledge base by the grower in decisions related to muscadine production either in place or being considered for future plantings. Consumers will benefit from this work, though in a longer-term manner, in that this work will contribute to higher quality muscadines in the commercial marketplace.

An actual number of beneficiaries are not known for Arkansas, as AAD doesn't have the resources to catalog all growers in the state and Arkansas's very open Freedom of Information Act does not allow us to keep producer data confidential which is a deterrent to building a list. However the 2012 USDA Agricultural census lists 145 farms with grapes in the state. In addition most varieties released by U of A end up being grown all through the south which cannot be said for other southern states releases. In addition, U of A believe there could be 5,000 home gardens in the state that have grapes.

Data on production of fresh-market muscadines (the primary fruit type targeted by this project) is not well documented in Arkansas. This is due to no viable statistics being gathered on this crop by statistical entities. Thus, there is no quantitative data to reflect impact at this point. It is known by observation and grower inquiry that muscadines are produced over much of the state, and are often found in farmers markets, and this marketing could be expanded to retail grocery store markets if more substantial plantings could be made of adapted varieties. This work therefore will flow directly to benefit this grower and production group. It is anticipated that acreage and production value will increase in Arkansas on muscadines due to this and other research underway to improve this crop.

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

Lessons learned beyond or within the results would include:

-Varieties and selections of muscadines have substantial differences in contents of various compounds and postharvest potential.

-The hot and dry year of 2012 was a great contrast to the more normal 2013 growing season, providing somewhat different results than first anticipated.

-Some variables such as percent unmarketable berries, percent weight loss increased during storage and force to penetrate the berry skin generally were most important for differentiating the genotypes, as opposed to other variables that changed little during storage.

- A committed and talented person such as Mr. Barchenger was the key to this immense amount of work done fully.

There were no unexpected outcomes in the project activities for 2013.

Outcomes were achieved as envisioned. Due to the long-term nature of this work, the commercial outcome is still several years from being realized. However, good progress is being made as determined any annual, additive progress in this overall effort.

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Additional Information

Publications

Barchenger, D.W., J.R. Clark, R.T. Threlfall, and S. Sleezer. 2014. Evaluation of seed and fruit characteristics of muscadine grape. J. Amer. Pomol. Soc. 68:204-208.

Barchenger, D.W., J.R. Clark, R.T. Threlfall, L.R. Howard, and C.R. Brownmiller. 2014. Effect of field fungicide applications on storability, physicochemical, and nutraceutical content of muscadine grape (*Vitis rotundifolia* Michx.) genotypes. HortScience 49:1315-1323.

Barchenger, D.W., J.R. Clark, R.T. Threlfall, L.R. Howard, and C.R. Brownmiller. 2015. Evaluation of physiochemical and storability attributes of muscadine grapes (*Vitis rotundifolia* Michx.). HortScience (In press).

Barchenger, D. W., J.R. Clark, R.T. Threlfall, L.R. Howard. 2014. Evaluation of field fungicide application ffects on nutraceutical content of muscadine genotypes. HortScience 49(9) (Supplement) – 2014 SR-ASHS Annual Meeting. P. S20. (abstract)

Barchenger, D.W., J.R. Clark, R.T. Threlfall. 2014. Muscadine grapes: Evaluation of genotypes and field fungicide applications on postharvest storage attributes. HortScience 49(9) (Supplement) – 2014 SR-ASHS Annual Meeting. P. S58. (abstract)

Figures of Data Mentioned in the Text

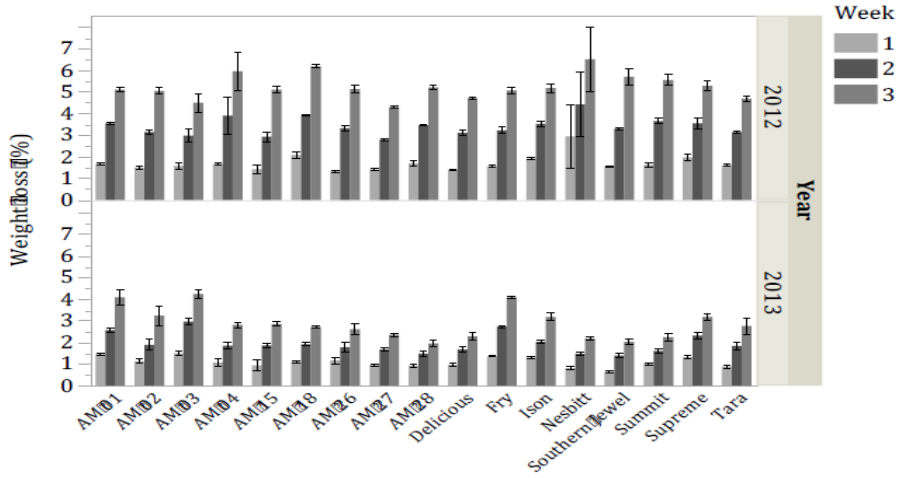

Fig. 1. Percent berry weight loss of muscadine genotypes stored at 2 °C for 3 weeks. Values at week 0 (date of harvest) were excluded. Each standard error bar is constructed using 1 standard error from the mean (2012 and 2013). Bronze genotypes were AM 01, AM 03, AM 15, AM 26, Fry. Summit, and Tara, and the black genotypes were AM 02, AM 04, AM 18, AM 27, AM 28, Delicious, Ison, Nesbitt, Southern Jewel and Supreme.

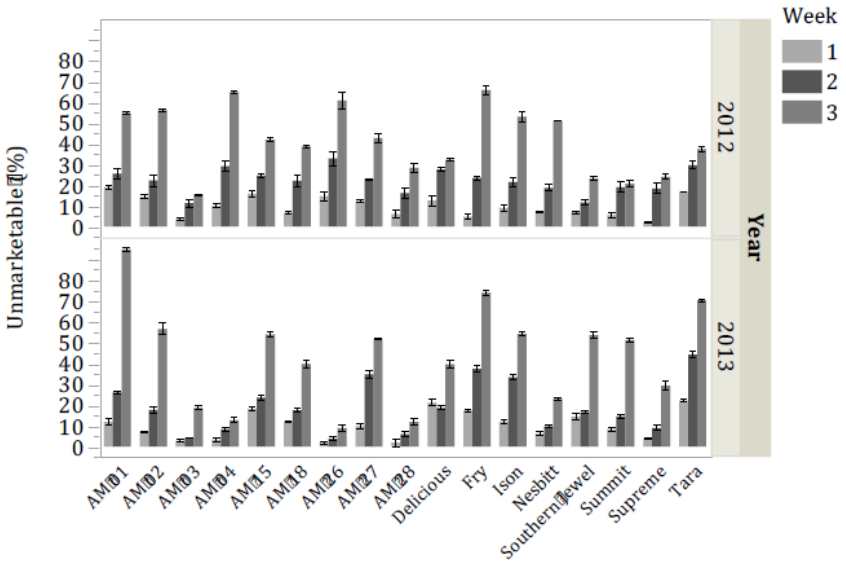

Fig. 2. Percent unmarketable berries of muscadine genotypes stored at 2 °C for 3 weeks. Values at week 0 (date of harvest) were excluded. Each standard error bar is constructed using 1 standard error from the mean (2012 and 2013). Bronze genotypes were AM 01, AM 03, AM 15, AM 26, 'Fry', 'Summit', and 'Tara', and the black genotypes were AM 02, AM 04, AM 18, AM 27, AM 28, 'Delicious', 'Ison', 'Nesbitt', 'Southern Jewel', and 'Supreme'.

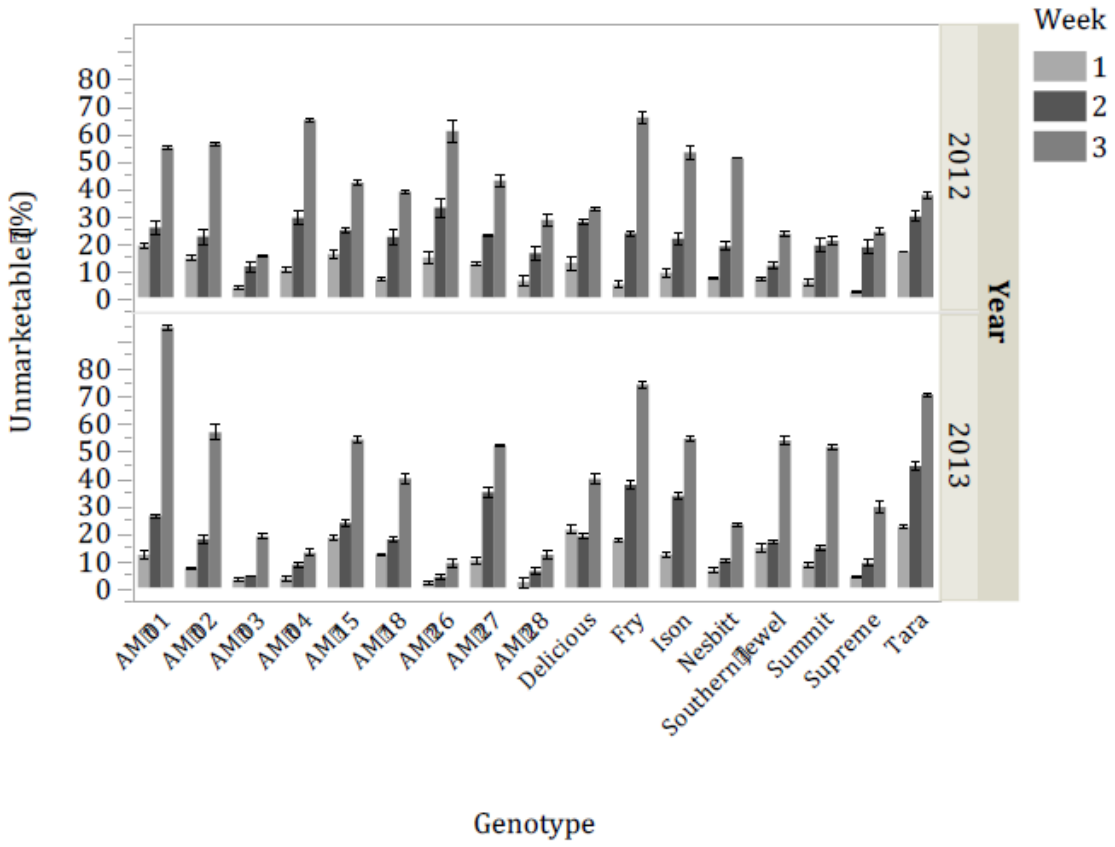

Fig. 3. Force to penetrate skin of muscadine genotypes stored at 2 °C for 3 weeks. Each standard error bar is constructed using 1 standard error from the mean (2012 and 2013). Bronze genotypes were AM 01, AM 03, AM 15, AM 26, 'Fry', 'Summit', and 'Tara', and the black genotypes were AM 02, AM 04, AM 18, AM 27, AM 28, 'Delicious', 'Ison', 'Nesbitt', 'Southern Jewel', and 'Supreme'.

Project 5: Produce Marketing Association Fresh Summit Show

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

Six specialty crop companies participated in the Arkansas Agricultural Department's (AAD) booth at the 2014 Produce Marketing Association (PMA) Fresh Summit International Convention and Exposition in Anaheim, California October 17-20, 2014. The companies are:

- Mathews Ridgeview Farms
- Delta Blues Sweet Potatoes
- Dominion Farms
- Post Familie Winery
- JYC/ Edamame
- Lowry Farms

Lowry Farms was the new participant in the AAD booth at the PMA Fresh Summit.

The companies were surveyed and the results are given under the goals section.

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

  Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

  Detail the significant contributions and role of project partners in the project.

Six specialty crop companies participated in the Arkansas Agricultural Department's (AAD) booth at the 2014 Produce Marketing Association (PMA) Fresh Summit International Convention and Exposition in Anaheim, California October 17-20, 2014. The companies are:

- Mathews Ridgeview Farms
- Delta Blues Sweet Potatoes
- Dominion Farms
- Post Familie Winery
- JYC/ Edamame
- Lowry Farms

Lowry Farms was the new participant in the AAD booth at the PMA Fresh Summit.

The following crops were showcased:

- Sweet Potatoes
- Grapes/Muscadines/Juice
- Tomatoes
- Cucumbers
- Squash
- Watermelons
- Edamame
- Peppers
- Zucchini

The participant companies produce the following:

- Sweet Potatoes
- Grapes/Muscadines/Juice
- Tomatoes
- Cucumbers
- Squash
- Watermelons
- Onions
- Hot Peppers
- Bell Peppers
- Edamame
- Zucchini

These growers are a very broad representation of AR specialty crops. They represent some of our biggest specialty crops, such as tomatoes, watermelons, and sweet potatoes.

Participants were recruited by a letter and email to all Arkansas producers who were GAP/GHP inspected or that AAD had knowledge of and were of a size that could benefit from the event. A survey was sent to all participants after the event and written survey results will be tallied and used to prepare for the 2015 show.

This year's booth was the same design as used in 2013. However, rental costs went up significantly due to the show being in California.

Even though attendance for the show was high, interest in the Arkansas booth was not as southern centric as last year's show in NOLA. However, the drought that struck the west coast in 2014, did help to steer interest towards the Arkansas booth as retailers were looking to diversify where they buy their specialty crops from as west coast supplies were tight.

We were on course to have a great show until an airline passenger that flew through the DFW airport tested positive for Ebola a few days before the show. A number of our producers then became scared to fly to Anaheim as all flights going from Little Rock to the west coast layover at DFW. Luckily, our newest producer, Lowry Farms, did attend along with JYC/Edamame. All the participants sent their marketing materials along with their samples. AAD Marketing Director Zach Taylor ended up representing those participants that did not show up in addition to setting up their displays for them.

The survey below was sent to all participants after the event:

2014 PMA FRESH SUMMIT
Anaheim, CA

1. WAS THIS SHOW HELPFUL?
   1 2 3 4 5 6 7 8 9 10
   YES → No

2. WILL YOU RETURN NEXT YEAR?
   1 2 3 4 5 6 7 8 9 10
   YES → No

3. DID YOU THINK ATTENDING "DID OR WILL" INCREASE YOUR SALES?
   1 2 3 4 5 6 7 8 9 10
   YES → No

4. ARE YOU HAPPY WITH THE BOOTH SETUP?
   YES NO: _____
   _____

5. HOW MANY SALES LEADS OR POTENTIAL SALES LEADS WERE MADE? _____

6. HOW MANY CONTACTS WERE MADE? _____

7. HOW MANY LEADS OF:

   NATIONAL: _____
   REGIONAL: _____
   LOCAL: _____

8. HOW ELSE WAS THIS SHOW HELPFUL?
   _____
   _____

9. SUGGESTIONS:_____
   _____

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.
- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

AAD achieved its goals and outcomes by constructing a booth at the 2014 PMA show and recording 25 potential sales leads as indicated in the survey results below.

Survey Results:

1. Average Score 1.4
2. Average Score 1.0
3. Average Score 1.7
4. All attendees responded with “Yes”.
5. Average sales leads were 24.5
6. Average contacts were 40
7. Averages were: NATIONAL: 8 REGIONAL: 11 LOCAL: 2
8. One of the response that was commonly reported was, ”The drought in Cali is really showing, I have leads I have never had before”.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

Beneficiaries were the specialty crop producers of Arkansas and especially those that attended the show with AAD. When Arkansas has a presence at these national shows all of Arkansas can benefit.

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

AAD has been attending this show and constructing this booth for a number of years now and thus most of the problems have been worked out.

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Project 6: Arkansas Grown

Project Summary

- Importance and timeliness of the project
- Did the project build on previously funded Specialty Crop Block Grant Program projects? If so, how did this project complement and enhance previously completed work?

Project Approach

- Briefly summarize activities and tasks performed during the grant period, addressing the tasks provided in the project proposal or work plan. Include significant results, accomplishments, conclusions and recommendations, as well as favorable or unusual developments.

  Did non specialty crops benefit from the project? If yes, how did the project ensure SCBGP Funds were used solely to enhance the competitiveness of specialty crops?

  Detail the significant contributions and role of project partners in the project.

State funds were used to conduct a market survey of the Arkansas Grown Program. From the survey we determined that the market segment for Arkansas Grown is adults over 25, who are either specialty crop producers or college educated consumers interested in purchasing local food. Using this data it was decided to contract with Hortus, Ltd, a state based marketing group that has experience of marketing in the specialty crop realm. Hortus Ltd is the marketing group of gardening and home celebrity P. Allen Smith (PAS). Mr. Smiths is the author of a number of gardening publications in addition to being the host of his own horticulture program on PBS. He is also the spokesman for Bonnie Plants and a number of other specialty crop related groups.

Mr. Smith's group was a natural fit for the relaunch of Arkansas Grown because, P. Allen's audience includes house-proud adults, DIYers, gardeners and farmers, who yearn for beauty, sustainability and affordability. They have an affinity for horticulture, local foods, and gardens. They think of their homes and gardens as places to create memorable occasions that bring friends and family together. Center of target is adults 35-56, primarily college-educated women with families who own their own homes.

Hortus employees sat down with AAD to look at ways of revamping the Arkansas Grown Program. It was decided that the re-launch needed to achieve the following:

- To further educate and engage consumers in Arkansas about the Arkansas agricultural community and create a call-to-action and preference to "Buy Arkansas" grown specialty crop products.

- To increase recognition of participating Arkansas specialty crop growers, producers, processors, wholesalers, retailers and restaurants within the Arkansas Grown programs.

- To continue to highlight the accessibility and amplify the awareness of where to find and purchase Arkansas Grown Specialty Crops and products to an audience of potential buyers.

To do this the following was done:

P. Allen Smith was established as "brand champion" and "voice" of Arkansas Grown Specialty Crops. This was done to establish and grow the Arkansas Grown Specialty Crop brands and to increase awareness and participation, by consumers, growers and retailers through PAS media channels. Mr. Smith as the talent and personality, educated and engaged consumers and used his established PAS audience to increase the popularity of Arkansas Grown Specialty Crops.

Hortus produced AAD-Arkansas Grown Specialty Crop segments to air within PAS Radio Show. The Arkansas Grown Segments contained interviews with Farmers, Chefs, Consumers (Mom/Food Blogger), and AAD.

AAD conducted the 1st Annual Local Food Conversation co-hosted by P. Allen Smith and First Lady Ginger for a special gathering of local farmers, farmer's market managers, and merchants/potential customers (chefs and store managers). This event was to get a dialogue going about what they want to see from the Arkansas Grown program in relation to specialty crops. A secondary goal was to link farmers with potential retailers.

PAS and AAD worked together to create and implement a yearly (in season) social media campaign positioning an Arkansas Grown Contest-Giveaway. We engaged followers to make comments about and share images of Arkansas Grown specialty crop products that they had purchased locally and to post recipes using those products for a chance to win prizes. A monthly contest winner was randomly selected and the prize "giveaways" are P. Allen Smith items . PAS engaged followers on Facebook, Twitter, Pinterest and Instagram with messaging related to Arkansas Grown program initiatives (i.e. community events, recipes or lifestyle-oriented messaging with Arkansas Grown products, etc.)

During June of 2014 PAS and AAD launched the 1st Annual Farm2Home Blogger Event co-hosted by P. Allen Smith and Arkansas Agriculture Department as a gathering of Arkansas bloggers at Allen's Garden Home Retreat at Moss Mountain Farm for a day of learning about local specialty crops. A opportunity was given for top level Arkansas Grown members to participate and help educate Arkansas bloggers about their farms and the local produce available to Arkansas families. A panel of four specialty crop farmers was put together for a Q & A season. Lunch was sponsored by a local food distributor and highlighted local Arkansas fruits and vegetables.

Hortus wrote and provided images related to the Arkansas Grown Programs to local (statewide/regional) publications (i.e. *AY* and *Front Porch* [Arkansas Farm Bureau]. In addition, Hortus also searched out other free media opportunities for the AG program to receive coverage.

Lastly, Arkansas Grown Specialty Crops was recognized sponsor of the PAS Garden Home Retreat at Moss Mountain Farm, which allowed PAS to position/promote the Arkansas Grown program during PAS Garden Home Retreat-Moss Mountain Farm Events. PAS recognize Arkansas Grown Specialty Crop products in use at the PAS Garden Home Retreat.

Goals and Outcomes Achieved

- Supply the activities that were completed to achieve the performance goals and measurable outcomes identified in the approved project proposal.
- If outcome measures were long term, provide a summary of the progress made towards this achievement.
- Provide a comparison of actual accomplishments with the goals established for the reporting period.
- Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and show the progress toward achieving set targets.
- Highlight the major successful out comes of the project in quantifiable terms.

A final survey was conducted in 2015. When surveyed eighty-seven percent responded that they are aware of the Arkansas Grown Program. When asked if they are more likely to buy a specialty crop if it's identified as Arkansas Grown, Ninety percent responded with a yes.

Beneficiaries

- Provide a description of the groups and operations that benefited from the completion of project's accomplishments.
- State the number of beneficiaries affected by the project's accomplishments and/or the potential economic impact of the project.

The beneficiaries are not only the specialty crop members of the Arkansas Grown, but also the number of consumers that have become aware of this program through the social media people and bloggers that were reached out to. An estimated 400 specialty crop producers benefited from this project, while an estimated 5,000 consumers increased their awareness of Arkansas specialty crops.

Lessons Learned

- Provide insight into the lessons learned as a result of completing the project.
- Provide unexpected outcomes or results of the project.
- If goals or outcome measures were not achieved, identify and share the lessons learned

This project went as planned.

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